2008
INTEGRATED RESOURCE PLAN

SNOHOMISH COUNTY PUD

APPROVED AUGUST 19, 2008

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1 OVERVIEW

Snohomish County Public Utility District (PUD) provides electric service to 316,000 residential and business customers in Snohomish County and Camano Island. To meet this responsibility, the PUD relies on power from the Bonneville Power Administration (BPA), two PUD-owned generating plants, three third-party power supply contracts, and a portfolio of conservation and energy-efficiency programs. In 2007, the firm power supplies from these sources totaled 796 average megawatts (aMW). Conservation programs met roughly 10% of the PUD's load.

The purpose of this Integrated Resource Plan (IRP) is to establish an action plan that ensures enough resources are available, at reasonable cost, to meet future loads. Achieving this objective requires consideration of all possible options and a plan that is adaptable to changing circumstances. Energy efficiency, renewable power supplies, purchased power contracts, and PUD-owned resources are all among the potential alternatives.

Preferred Plan

The PUD's IRP was developed by analyzing six resource portfolios, each designed to meet different load and economic conditions. From this evaluation, a single Preferred Plan was formed, which considers cost, reliability, risk, and operational constraints. The Preferred Plan was heavily influenced by two PUD Commission guidelines:

- Rank conservation as the resource of choice for meeting load growth. Pursue all cost-effective energy-efficiency measures and look for ways to accelerate the acquisition of savings where possible and economical.

- To meet loads not served by conservation, pursue a diversified portfolio of low-cost BPA power and renewable energy. To the extent possible, the new resources should be located in the PUD's service area.

The Preferred Plan meets both of these criteria and positions the PUD as a leader in conservation and renewable resource development. The Preferred Plan calls for 96 aMW of new cost-effective conservation—more than all of the PUD's achievements to date. And it establishes a "stretch" goal of 5% more energy efficiency. Additional power supplies would come from a mix of BPA, wind and landfill gas contracts, and from small hydro, geothermal and tidal energy projects the PUD would own and operate.

The Preferred Plan ensures the PUD will continue to meet the electric demands of its customers efficiently and reliably; it is fully compliant with Washington State's Renewable Portfolio Standard, I-937; and it provides flexibility by giving the PUD options for delaying or accelerating resource acquisitions if loads grow slower or faster than expected.

Beginning in 2014, the PUD would add the first of a series of geothermal power plants located in Snohomish County. Although there is evidence of geothermal energy in Washington state, there has been little exploration and no utility-scale development. A new technology, Enhanced Geothermal Systems (EGS), expands the number of sites that could be used for power production. Under the Preferred Plan, the PUD would pursue this new option as well as traditional technology approaches. If successful, the PUD would establish geothermal power as a renewable resource that would meet the needs of Snohomish County residents for many years to come.

Table 1-1 presents the details of the Preferred Plan. Sections 6 and 7 describe the assumptions and reasons behind the resource choices.

Table 1-1

Snohomish PUD Preferred Resource Plan
(aMW)

	2008	2010	2012	2016	2020
Expected Loads	818.5	861.9	895.5	951.1	1,011.1
New Conservation (w/ line losses)	(7.2)	(21.2)	(35.6)	(65.4)	(96.0)
Net Loads after Conservation	**811.2**	**840.7**	**859.8**	**885.6**	**915.1**
Existing Resources[1]:					
BPA Contracts	699.3	699.3	699.3	699.3	659.1
Jackson Hydro	29.5	29.5	29.5	29.5	31.5
Everett Cogeneration	37.0	37.0	37.0	37.0	0.0
Wind (White Creek)	4.9	4.9	4.9	4.9	4.9
Klickitat Landfill Gas	4.9	0.0	0.0	0.0	0.0
Hampton Biomass	1.0	1.0	1.0	1.0	0.0
Market Purchases	24.5	0.0	0.0	0.0	0.0
PSE Conservation Transfer	(10.2)	(1.7)	0.0	0.0	0.0
New Resources[1]:					
BPA Tier 1 and 2	0.0	0.0	54.0	49.0	49.0
New Wind	0.0	58.0	58.0	58.0	58.0
Biomass/Landfill Gas	0.0	4.9	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	5.0	5.0
Tidal	0.0	0.0	0.0	1.0	5.0
Geothermal	0.0	0.0	0.0	30.0	90.0
Short/Term Market Purchases	20.3	5.8	(35.7)	(38.9)	(7.2)
Total Planned Resources	**811.2**	**840.7**	**859.8**	**885.6**	**915.1**
% of I-937 Eligible Renewables	1.4%	8.2%	10.8%	14%	21.6%
Renewable Energy Surplus	11	69	68	46	61

[1] Includes line losses, under critical water conditions.

Action Plan

The actions necessary to carry out this plan are shown below.

1. **Implement all cost-effective energy conservation measures.**
2. **Actively pursue conservation "stretch" goals and continue to seek new opportunities for customers to save energy and reduce demand.**
3. **Work with BPA to establish a 2012-2028 power supply contract that maximizes the benefits of the federal power system to the PUD.**
4. **Negotiate long-term contracts for renewable resources with third party providers.**
5. **Immediately begin development of geothermal resources in or near Snohomish County with a target commercial operation date of 2014 for the first power plant.**
6. **Continue research and development of tidal energy systems in Puget Sound.**
7. **Evaluate and, where appropriate, pursue small-scale hydroelectric opportunities in Snohomish County.**
8. **Where appropriate, encourage customer-ownership of small-scale resources.**
9. **Participate in regional transmission forums to ensure adequate transmission capacity is available to deliver BPA and other generating resources to PUD loads.**
10. **Continue to monitor emerging technologies and further develop staff knowledge, tools and databases used to evaluate both supply and demand-side resource options.**

Through these actions the PUD will be prepared to serve the electricity needs of its customers well into the future.

Organization of the Document

This document is organized into eight sections:

- Section 1 is this overview.
- Section 2 describes the PUD's load forecasting methods and range of expected energy demands.
- Section 3 catalogs the PUD's current resources.
- Section 4 provides a backdrop to the planning process—outlining industry dynamics and recent legislation affecting utility operations.
- Section 5 addresses the analytic framework used to evaluate supply and demand-side resources.
- Section 6 describes the array of resource options available.
- Section 7 presents the development and evaluation of the Preferred Plan.
- Section 8 outlines the Action Plan necessary to implement the plan.

2 ENERGY REQUIREMENTS

Forecasts of future loads are the starting point for integrated resource planning; they are the primary determinants of the PUD's need for future resources. PUD staff developed six separate forecasts: a Base Case load forecast representing the most probable future, two sensitivity cases that vary the input assumptions within the Base Case, and three additional forecasts corresponding to three possible future scenarios. Each load forecast takes into account economic drivers, customer electricity usage patterns, impacts of past conservation and energy-efficiency programs, as well as other factors.

Base Case Forecast

Figure 2-1 below compares the Base Case forecast to the PUD's historical loads, measured in megawatt-hours. Since 1970, loads have grown at an average annual rate of 2.3%. This trend would have been higher, roughly 2.6% per year, were it not for the PUD's prior emphasis on conservation. Between now and 2012, total electrical demands (absent conservation) are expected to grow by 13%, reflecting the county's continued economic prosperity and rise in population. Industrial loads are expected to remain at current levels.

Figure 2-1

Annual MWh Retail Sales

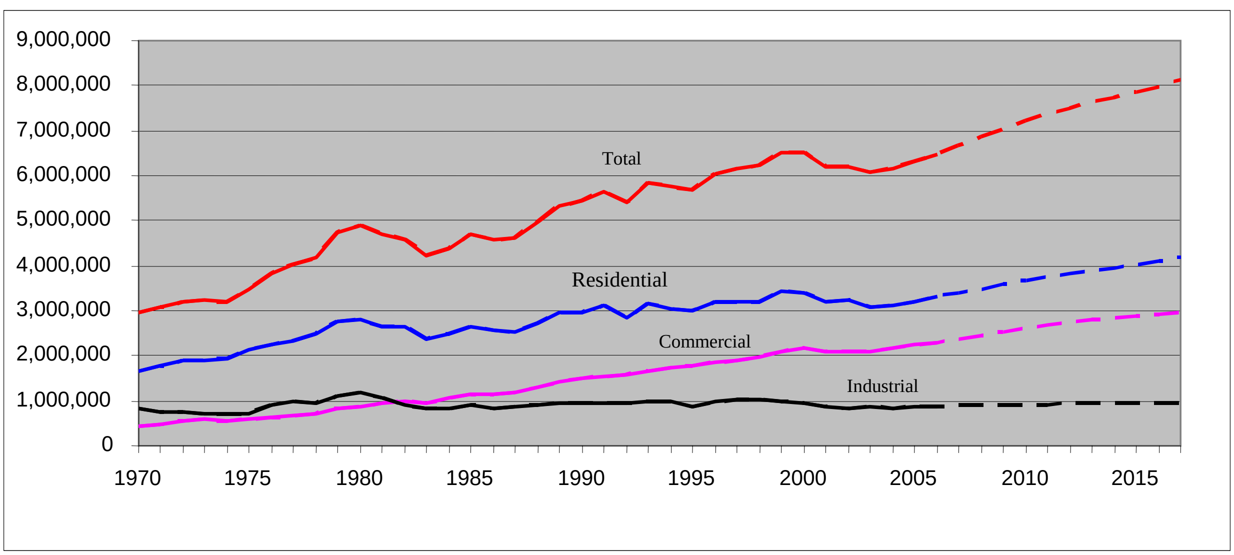
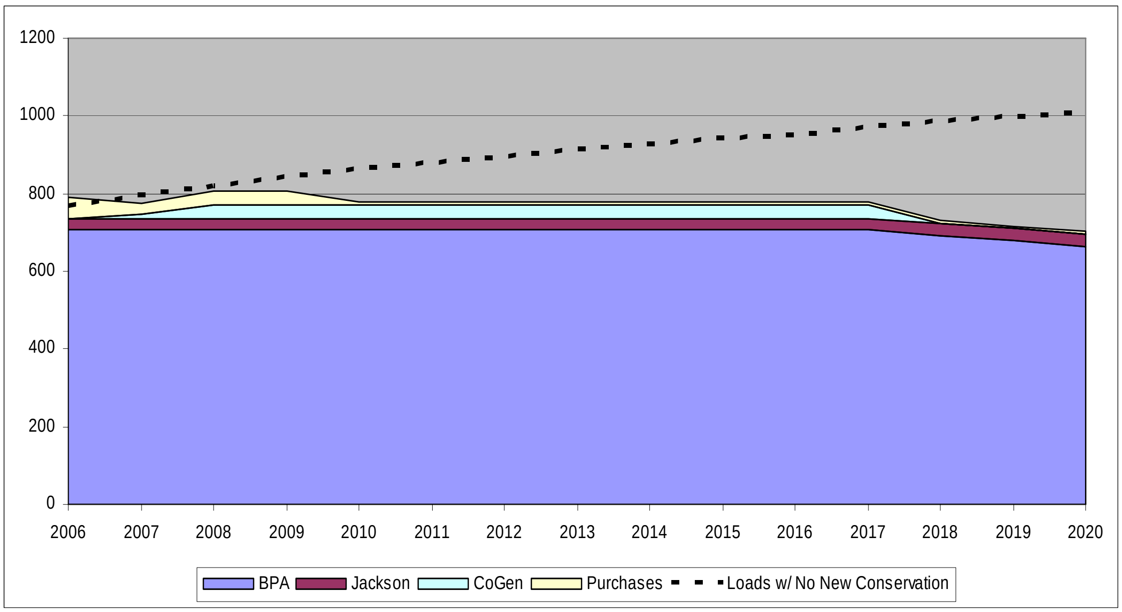


Figure 2-2 below compares the Base Case forecast with the PUD's resources under critical water conditions;[1] assuming no new savings from conservation programs. Under these conditions, the PUD does not currently have enough resources under contract or owned to meet loads. By 2020, the gap widens to roughly 240 aMW.

Figure 2-2

Loads and Resources (aMW) without New Conservation
March 2007 Load

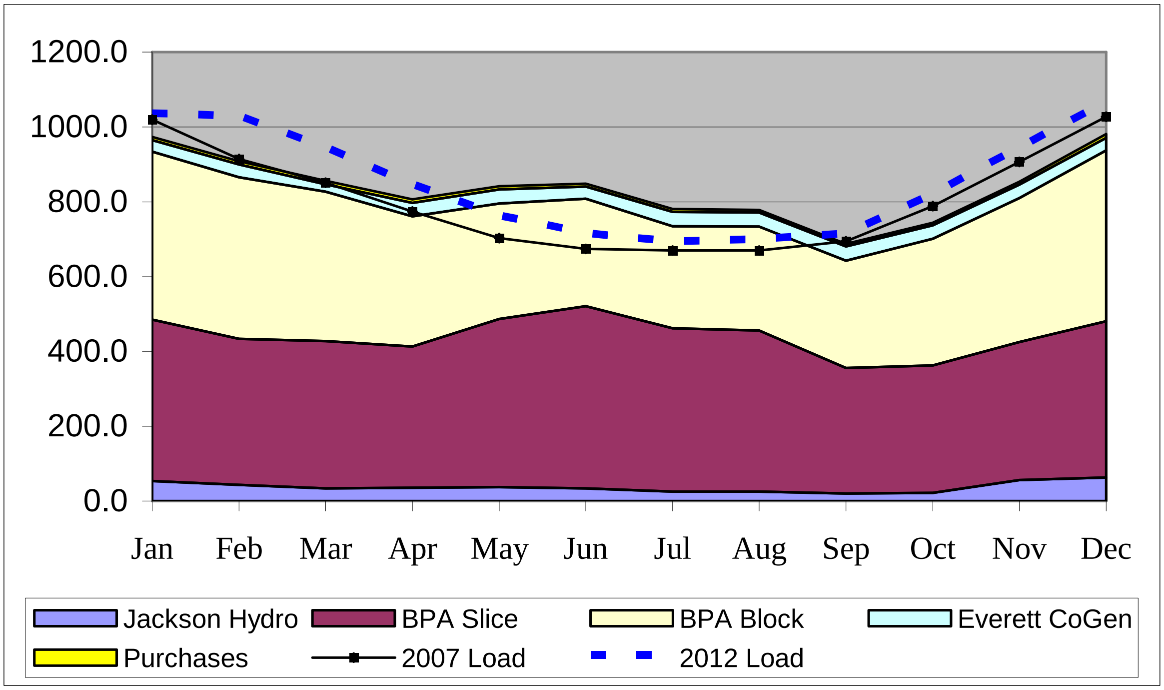


The seasonal shape of the PUD's loads and resources is also an important consideration. The PUD's loads have historically been highest in the winter and that remains the case, although summer air conditioning loads are increasing. The PUD's resources, however, produce more energy in the spring and fall than in the winter or summer. This pattern results in monthly surpluses and deficits that the PUD must manage. Figure 2-3 below illustrates by comparing forecasted loads for 2007 and 2012 with the PUD's existing resources under "blend" water conditions.[2]

[1] Critical water conditions represent energy output assuming the lowest rainfall seen in the last 70 years.
[2] "Blend" water conditions represent a year half-way between average and critical water conditions.

Figure 2-3

Snohomish PUD Current & Forecasted Firm Loads & Resources (aMW)
2007 and 2012



Deficits occur in October through March with surpluses April through September. The imbalances are made up by selling or purchasing energy in the short-term wholesale power market.

Forecast Methods and Assumptions

The PUD forecasts future customer loads using a combination of end-use and econometric methods. Economic inputs and other fundamental growth assumptions come from a model of Snohomish County developed by Conway-Pederson, Inc. This model predicts population, employment, income, housing stock, and inflation based on historic relationships. Staff relies on an end-use model[3] to forecast residential loads. This model is modified to include econometrically determined price and income elasticities. The PUD uses forecasts of

[3] An end-use model forecasts loads based on the number and type of appliances in customers' homes and businesses and other electricity consumption (end-uses).

population growth to predict the number of residential customers it will serve. Residential customers are divided into housing types (single-family, multi-family and manufactured/mobile home) and heating categories (electric or non-electric). Projected incremental energy use is added to existing use by housing type and heat source. Final adjustments are then made for past conservation, electric-to-gas conversions, and income and price elasticity.

Staff forecasts commercial loads based on county employment in the goods-producing, service-producing and military sectors. Loads for small industrial customers are estimated by multiplying the number of customers by a constant annual kilowatt-hour (kWh) use per customer. Loads for large industrial customers are forecast based on feedback received from PUD Account Executives, along with information provided from customers themselves.

For this load forecast, staff assumed there would be no change in the PUD's retail rates. Staff assumed the county's population would grow at roughly 2.2% per year, which when combined with a falling average family size, corresponds to a 2.7% annual rise in employment. Most of the employment expansion is expected to occur in the service sector, which will add 31,000 jobs over the next five years, mainly in retail and wholesale trade, finance, education and health services, and government. In the goods-producing sector, 18,000 new jobs are expected with the biggest gains in aerospace and construction.

Figure 2-4 below shows the downward trend in new single-family all-electric homes, which fell below 10% in 2002. Staff assumed about 750 customers would switch heat sources from electricity to natural gas each year. Multi-family dwellings and manufactured/mobile homes are expected to remain predominantly heated by electricity at roughly 80% and 100% respectively. As illustrated in Figure 2-5, single-family homes are expected to continue to account for 70% of all home types.

Figure 2-4

Single-Family Electric Heat Penetration Rate

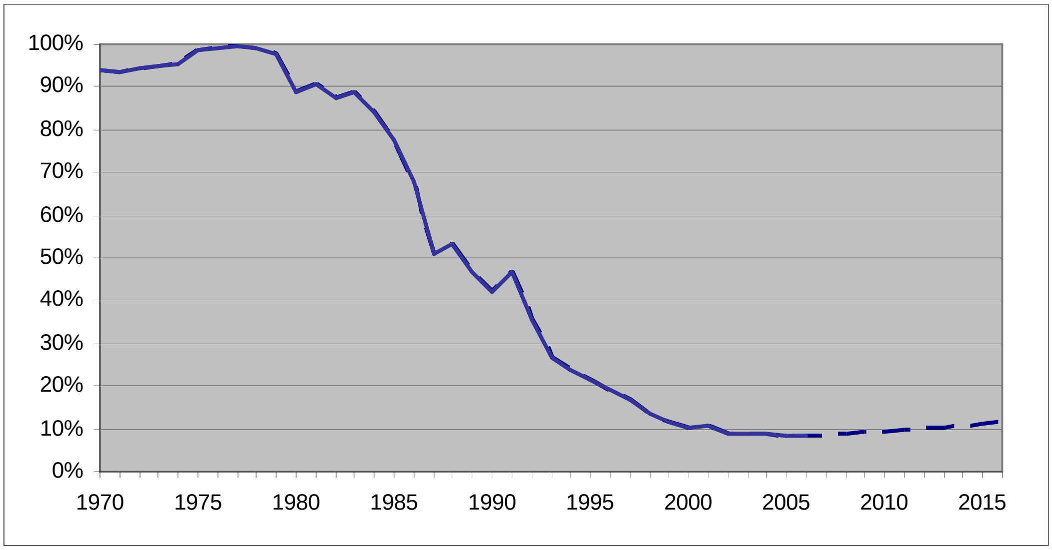
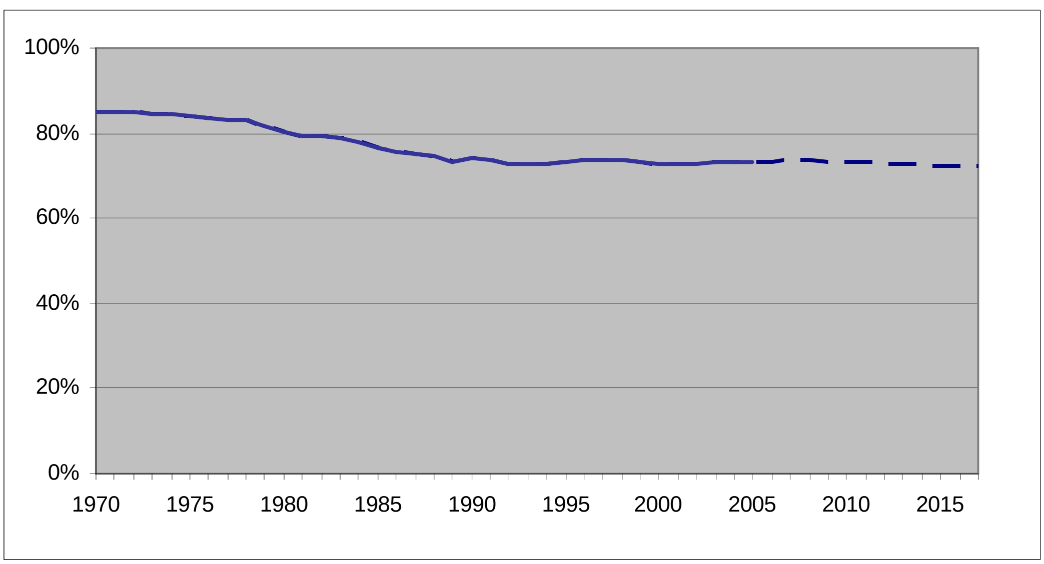


Figure 2-5

Single-Family Share of Total Homes



The Base Case load and forecast table shown below contains year-by-year information on energy by customer type.

Table 2-1

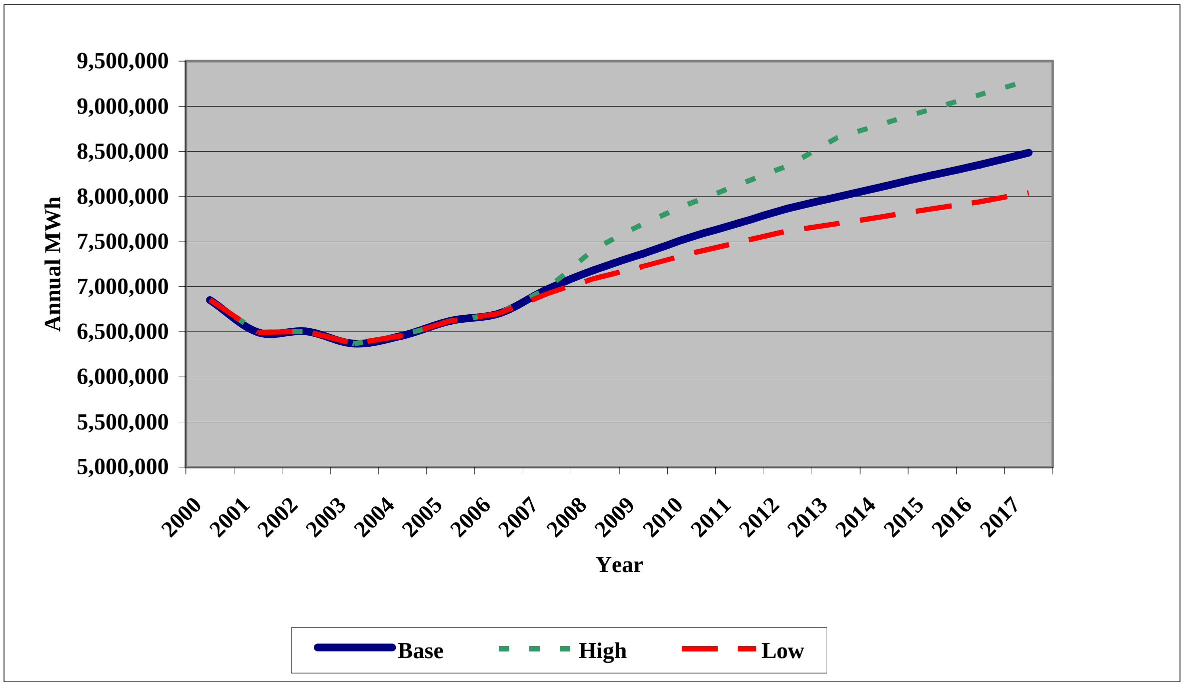
Base Case Load Forecast without New Conservation

	2007 (Actual)	2008	2012	2016	2020
MWH Sales					
Residential	3,478,709	3,485,898	3,811,211	4,094,500	4,422,031
Commercial	2,374,925	2,457,157	2,742,847	2,914,221	3,076,677
Industrial	896,203	905,710	938,968	949,045	961,253
Other	24,804	24,174	26,618	28,761	30,825
Total	6,774,641	6,872,939	7,519,644	7,986,527	8,490,786
System Requirements	6,969,030	7,189,267	7,865,737	8,354,108	8,881,575
Avg MW Requirements	796	818	895	951	1,011
Peak MW Requirements	1,418	1,442	1,543	1,615	1,693
Annual Growth Rate	4.5%	3.2%	2.0%	1.4%	1.5%
Customers (Annual Average)					
Residential	283,927	297,084	327,125	353,462	378,835
Commercial	28,446	29,494	31,918	33,735	35,576
Industrial	78	80	84	88	92
Other	316	332	366	395	424
Total	312,767	326,991	359,493	387,681	414,926
New Connections					
Residential Single Family	6,800	6,200	4,900	4,500	N/A
Residential Multi-Family	1,800	2,400	2,500	2,500	N/A
Commercial & Industrial	1,000	1,000	900	800	N/A
Total	9,600	9,600	8,300	7,800	N/A

Figure 2-6 below shows how the Base Case forecast is influenced by changes in input assumptions.

Figure 2-6

Annual MWh Retail Requirements
Base, High and Low Forecasts w/o New Conservation



In the "low" case, loads increase at a 0.8% annual rate, due to the following assumptions:

- The number of new customer connections is roughly 50% lower than the Base Case;
- The share of new electrically heated, single-family homes built each year falls;
- Fuel switching from electric to natural gas increases from 750 to 1500 annually;
- County and national economic conditions are assumed to worsen, with unemployment rates of 7%; and
- PUD retail rates are assumed to rise.

In the "high" case, loads grow at a 3.3% annual rate versus the Base Case 2.0% rate because:

- Population growth increases relative to the Base Case;
- The share of new single-family homes with electric heat grows;
- Fuel switching diminishes;

- Natural gas prices are higher;
- Significant new commercial and industrial loads join the PUD; and
- County and national economic conditions improve.

Scenario Forecasts

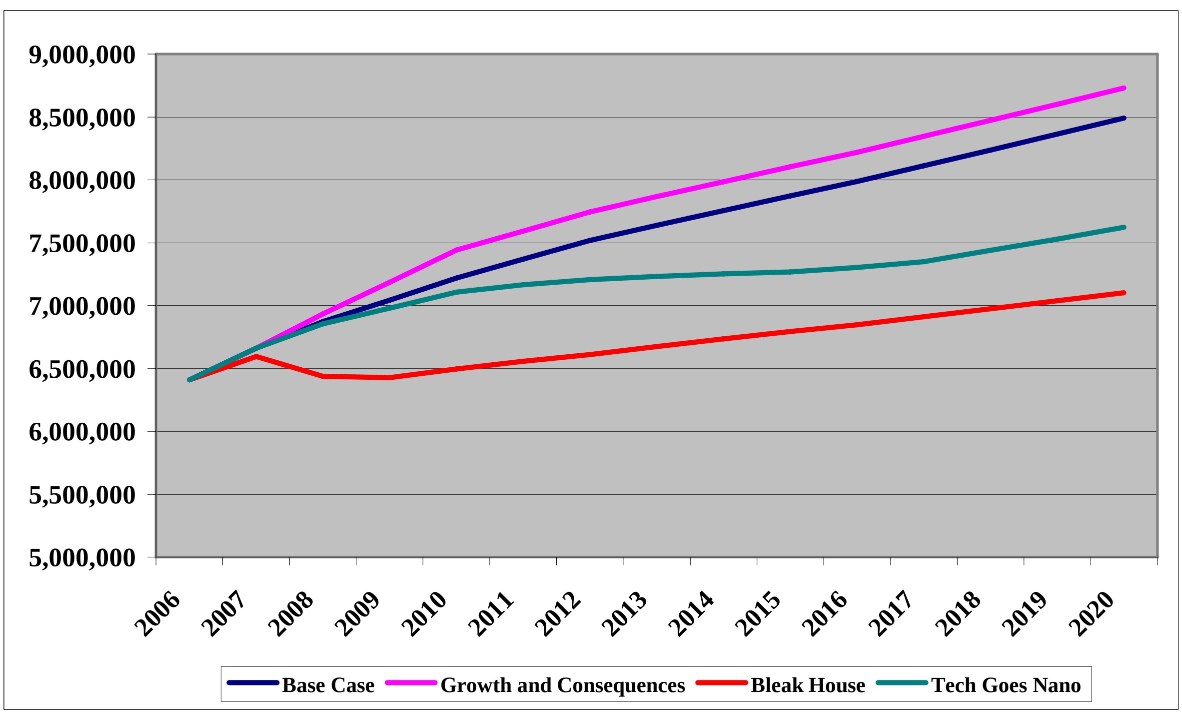
To capture future uncertainties and the broad set of risks faced by the PUD, staff created three scenarios (or paradigm shifts) and corresponding load forecasts. These scenarios were named:

- Growth & Consequences
- Bleak House
- Tech Goes Nano

Figure 2-7 illustrates the impact of each scenario on retail sales as it relates to the Base Case.

Figure 2-7

Retail MWh Sales @ Meter w/o New Conservation



Growth & Consequences

Growth & Consequences models a future where Snohomish County continues to experience robust economic growth and prosperity. Stronger world governance minimizes national security threats, providing economic stability. The Everett area benefits from Boeing's strong presence, new industry, waterfront and riverfront development, a major cancer research center, and a new international airport at Paine Field. Population and income growth remain strong.

Global warming is curtailed by industry efforts, citizen awareness and government mandates. Utilities succeed in meeting renewable portfolio standards, but the effort impacts retail electric rates, which rise 50%. More companies and residents adopt carbon-neutral lifestyles—offsetting carbon footprints by purchasing green tags, planting trees and driving plug-in hybrid vehicles. New transmission infrastructure and power supply from out-of-area help meet electric demand. Higher natural gas prices and volatility are offset by more renewable energy produced in the region.

Appendix C presents a complete description of this, as well as the other two scenarios.

Bleak House

Bleak House is a different story. This scenario postulates a future in which things go wrong. The federal budget is strained by war efforts. Terrorism is driven underground, yet remains ever-present. U.S. industry suffers the consequences of a flattened global market, dominated by China and India; the standard of living for most Americans drops significantly. Snohomish County fares worse than the rest of the nation with high unemployment rates and higher-than-average regional inflation.

The four lower Snake River Dams are breached, which causes a domino effect across the Northwest. Power prices rise as supply tightens and utilities struggle to meet state renewable portfolio standards. There is not enough power to go around. Congress allocates a portion of BPA power to California, which further limits supplies for the Northwest. Residential consumers reluctantly pay higher electric rates and industry relocates elsewhere or downsizes in response to high power costs.

On the plus side, a major cancer center is built, centralizing cancer care services for several surrounding counties. Cancer research and support services take up residence on the city blocks that surround the center. Increases in employment for health care offset the loss of industrial jobs to some extent.

The media spreads tales of doom with stories of Yellowstone’s possible explosion and seismic rumblings from both Mt. St. Helens and Mt. Rainier. People rein in their finances and spending. Global warming affects the Pacific Northwest, drying up streams in summer months, changing run-off patterns, killing salmon, and melting the snowpack and glaciers that bank critical water supply.

The load forecast associated with The Bleak House scenario is 11% below the Base Case, reflecting:

- New customer connections that are 50% lower;
- Loss of one large industrial company that closes down local operations;
- Greatly reduced operations at another large industrial company;
- A regional cancer research and treatment center is built in the county; and
- Global warming that creates changes in the shape of output from the region’s hydroelectric generation.

Tech Goes Nano

Tech Goes Nano explores a future in which atomic scale nanotechnology takes center stage, redefining the worlds of science, manufacturing, communication, energy, security, computing, warfare, and more. Nanotechnology changes the world in a relatively short time. Washington state quickly takes advantage of the nano-transformation, investing in and promoting nano-based businesses across the state and particularly in Snohomish County. The population doubles as more jobs are created, more homes are built, and a nano-tech/Green MBA program at a new four-year university draws students from across the nation.

In the electric utility sector, new nano-technology applications reduce the cost of renewable energy. A Continental SuperGrid enables the delivery of both electrons and hydrogen across one superconducting line. This allows hydrogen energy sources to gain footing and proliferate from major cities to rural towns. Fuel cell transportation and plug-in hybrid vehicles become mainstream. There are many more opportunities for conservation, but new home entertainment technologies offset some of the efficiency gains.

Under the Tech Goes Nano scenario, loads drop 5% below the Base Case forecast.

- Industrial loads drop significantly due to efficiency gains;
- Fuel cells and distributed generation result in lower utility loads for residential, commercial and industrial customers;
- A new international airport at Paine Field is completed;
- Carbon cap-and-trade legislation is implemented in 2012; and
- Two new nuclear plants are added to the region and affect energy prices in the long-term.

3 PUD RESOURCES

The PUD relies on a portfolio of resources to meet customer demands:

- BPA Block and Slice contracts
- Conservation programs
- PUD-owned generating assets
- Third-party power supply contracts
- Regional transmission contracts

BPA Block and Slice Contracts

The PUD currently purchases two types of power products from BPA—"Block" and "Slice" totaling 699 aMW.[1] Together, these two contracts account for roughly 90% of the PUD's power requirements. The PUD manages BPA power in concert with its owned resources to serve load.

The Block product provides the PUD with power in flat monthly amounts that average 353 aMW over a year. In 2007, the total annual cost for the Block product was $79 million.

The Slice product is delivered in variable amounts that reflect the actual output of BPA's power system. It provides the PUD the ability to store and dispatch energy within the limits of BPA's resources. Slice offers both challenges and opportunities. Since the PUD takes responsibility for managing its portion of the federal hydro system, it assumes the inherent risks as well. If the hydro system is producing at peak, the PUD does well. If water supplies are low, then the PUD's energy supply is smaller.

Managing risk associated with the Slice product places responsibility on PUD's power schedulers to match seasonal and hour-to-hour variations in output. This involves monitoring snowpack and precipitation levels, market prices, temperature variations, and shifting customer demands. The cost of Slice contract energy is based on a percentage share of BPA's

[1] After losses are considered.

actual operating costs. In 2007, the PUD paid BPA $108 million for Slice output. After accounting for wholesale power sales, the net cost to the PUD was $74 million.

Both the Block and Slice contracts expire in 2011. PUD staff is currently working with BPA and other BPA customers to develop products and contracts for 2011 and beyond.

PSE Conservation Transfer Agreement

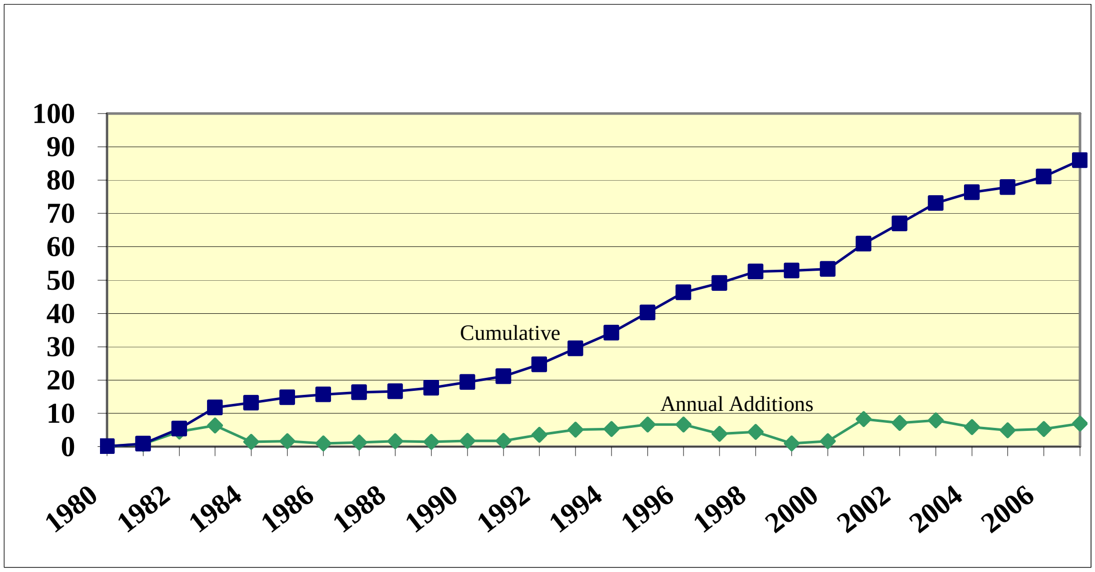
The Puget Sound Energy Conservation Transfer Agreement began in 1990 when BPA initiated a pilot program to transfer the benefits of conservation between three PUDs and Puget Sound Energy (PSE). For Snohomish, the amount of energy transferred was set at 10.6 aMW per year. In 2001, BPA's participation in the program ended, resulting in a power sales agreement between the PUD and PSE, which runs through February 28, 2010.

Conservation Programs

The PUD has been actively engaged in energy efficiency and demand-side management for over two decades. Since 1980, PUD programs have cumulatively acquired over 86 aMW of conservation resources (see Figure 3-1 below). The PUD offers education services, financial incentives, appliance rebates, and customized programs to all customer segments. Using engineering data, staff estimates that over the past 10 years, PUD programs have generated savings of roughly 5 aMW per year at an average cost of just under 3 cents per kWh.

Figure 3-1

PUD Annual Conservation Savings
aMW



Residential Weatherization Program

The objective of this program is to reduce the energy consumption of electrically-heated homes. The program offers financing or rebates to encourage customers to install floor, wall, ceiling and duct insulation, high-efficiency heat pumps, and insulated windows. Customers can obtain low-interest, 10-year loans at a current rate of 2.9% with no fees or up-front costs. Alternately, customers can choose up-front cash incentives to offset part of their efficiency investment. The program started in the early 1980s and has evolved to meet the needs of customers and the PUD. Savings depend on the measures selected and the specific characteristics of the home, including: the size of the home, schedule of occupancy, the initial level of efficiency, etc. Savings achieved in 2007 was 0.17 aMW. The savings goal for 2008 is 0.13 aMW, with a stretch goal of 0.16 aMW.

Residential Resource-Efficient Appliance Rebates

The objective of this program is to encourage residential customers to purchase resource-efficient ENERGY STAR® appliances. The current program started in September 1999. Participants are offered a $75 rebate for qualifying clothes washers and a $35 rebate for qualifying dishwashers (both of which save energy and water). Customers can apply for the rebate within 30 days of purchasing a qualifying unit. PUD water customers can receive an additional $50 toward purchase of an efficient clothes washer. In 2007, savings from this program was 0.27 aMW. Savings of 0.3 aMW and a stretch goal of 0.35 aMW are targeted for 2008.

Residential Compact Fluorescent Lighting (CFL) Program

The objective of the CFL program, which began in September 2000, is to reduce energy consumption related to residential lighting. Customers receive a coupon for $1-off of the regular price of an ENERGY STAR qualified CFL bulb. The customer redeems the coupon when purchasing qualifying CFLs from the PUD's retailer network. The PUD also buys down the cost of the bulbs at the wholesale level and establishes a competitive and reliable market for manufacturers and wholesalers. The buy-down reduces the cost to the retailers and provides additional savings to consumers. Retailers are reimbursed at face value for each coupon they submit to the PUD. There are many retail outlets in the county participating in the program. Beginning in 2008, the program increased focus on specialty CFLs, including reflector bulbs for recessed can lights, globe lights and three-way bulbs.

The PUD currently offers a CFL fixture program in conjunction with other Puget Sound utilities. PUD customers, as well as homebuilders, can receive a $20 instant rebate for each qualifying ENERGY STAR CFL fixture purchased at participating lighting showrooms in the Puget Sound area. Participating showrooms also receive an incentive for each fixture sold.

Savings from compact fluorescent bulbs and fixtures in 2007 was 1.7 aMW. The 2008 savings goal for these measures is 1.4 aMW. A stretch goal of 1.7 aMW has also been established.

Residential Refrigerator/Freezer Recycling Program

The objective of this program is to save energy by eliminating inefficient second residential refrigerators and freezers in an environmentally safe way. The PUD funds local appliance recycler, JACO Environmental, to operate the program on its behalf. JACO handles customer calls, tracking, payment, pickup, and recycling. The program offers a $30 payment to customers willing to dispose of old refrigerators and freezers still in operation. The collected appliances are recycled at a JACO Environmental facility in Everett, WA, according to strict guidelines from the U.S. Environmental Protection Agency. Over 95% of each refrigerator and freezer is recycled. Customers save 700 kWh or more per year by disposing of an inefficient second refrigerator or freezer. Snohomish PUD first piloted this effort in the region in 2005. It has since been adopted by others, including neighboring Puget Sound utilities, beginning in 2007. In 2007, savings of 0.35 aMW was achieved. The goal for 2008 is 0.4 aMW, with a stretch goal of 0.45 aMW.

Residential New Construction Program—"Build with ENERGY STAR"

This program is designed to encourage builders to include energy-efficient measures in new homes built in Snohomish County and on Camano Island. The rebates help offset the cost of installing higher energy-efficiency features in new single-family and multi-family homes. Rebates are offered for: high efficiency heat pumps; ENERGY STAR appliances, including clothes washers, refrigerators and dishwashers; and efficient lighting options. The program also includes a bonus rebate for including an advanced lighting package with a minimum of 28 CFL fixtures (i.e., 60% or more of the fixtures in a new home). Builders can also take advantage of special pricing on pin-based CFL fixtures at participating lighting showrooms. As a new initiative in 2008, the savings goal is 0.05 aMW; the stretch goal is 0.08 aMW.

Residential Low Income Housing Improvement Program (HIP)

The objective of this program is to reduce home energy use for low-income consumers. The program offers funding to community-based organizations for energy-efficient improvements in low-income transitional housing. Projects include weatherization, lighting, heating, efficiency upgrades, and demonstration projects related to renewable resources. Organizations apply for funding. For each application, the PUD considers the costs involved, the level of energy savings, the number of people served by the organization, whether the organization has received PUD funding in the past, secondary impacts of the project (health, safety and comfort), and whether there are other matching funds which can be leveraged.

Residential Matchmaker Program

The objective of the Matchmaker Program is to reduce residential energy use by low-income customers with electrically heated homes. By reducing energy use, customers are better able to pay their utility bills and require less assistance from the PUD. The program offers qualifying low-income customers free energy-efficiency upgrades to their home, including: wall, floor, ceiling, ducts, and water pipe insulation; air and duct sealing; water-saving low-flow showerheads; faucet aerators; ENERGY STAR refrigerators; and compact fluorescent lights. Customers are qualified through the Snohomish County Weatherization Department, which schedules, inspects and pays the contractor for the improvements. Contributions from the PUD are matched by Washington state managed Matchmaker funds.

The overall savings target for the low-income HIP and the Matchmaker programs is 0.14 aMW.

Commercial & Industrial Incentives for Existing Buildings

The objective of these commercial and industrial incentive programs is to reduce energy use in non-residential buildings. The core program offers commercial and industrial customers technical assistance, as well as an incentive of up to $0.17 per kWh for every kWh saved in the first year after installation, up to 70% of the cost of the energy-efficiency project. Efficiency measures funded include: lighting controls and fixtures, HVAC equipment, compressed air systems, motors, pumps and fans, refrigeration, heat recovery systems and controls, and variable frequency drives. PUD Energy Utililization Engineers work closely with the Executive Account Managers to identify solutions specific to the needs of commercial and industrial customers, particularly those with large energy use. In 2007, this program achieved savings of 2.3 aMW. In 2008, the savings goal is 2.1 aMW; the stretch goal is 2.25 aMW.

Commercial and Industrial Rebates

To complement the custom incentives and create options designed to make it easier for small business customers to participate in efficiency programs, the PUD has developed a menu of standard rebate offers. The following are included in the standard rebate offerings:

Lighting Rebates
This is a new program available to PUD customers to encourage installation of high efficiency lighting systems. Customers can obtain rebates of up to $7,500 for high-performance T8s, T5, CFL or HID (high intensity discharge) fixtures. Lighting contractors and vendors are encouraged to submit proposals to businesses with which they are working. With predetermined rebate amounts available on a wide range of lighting technologies, contractors can include the rebates in describing the overall economics and benefits of a project to the customer.

Energy Smart Grocer
Implemented in cooperation with BPA[2], this program is targeted to grocery and convenience stores, and other facilities with refrigeration equipment. A system audit is conducted to assess efficiency opportunities in individual facilities. Direct installation of low-cost measures and incentives towards the cost of installing more comprehensive refrigeration and lighting upgrades are provided.

Commercial Kitchen Equipment
The PUD makes cash rebates available through restaurant equipment suppliers for energy-efficient qualified commercial refrigerators and freezers, ENERGY STAR qualified food steamers, fryers and food-holding cabinets. This program element is offered in coordination with other Puget Sound utilities, including PSE, to provide incentives for high-efficiency gas technologies where applicable. Additional measures are under consideration.

[2] BPA has contracted with Portland Energy Conservation, Inc. (PECI) to promote this program throughout the Northwest.

Launched late in 2007, the program achieved savings of 0.03 aMW. In 2008, savings of 0.75 aMW is targeted.

Commercial and Industrial Incentives for New Construction

The objective of this program is to reduce the future energy consumption of commercial and industrial facilities under construction. Working with businesses early in the design phase of a project allows the PUD to identify a broad range of energy-saving opportunities and then offer technical assistance and financial incentives for projects that incorporate energy-efficiency measures. Financial incentives ranging from $0.15 to $0.25 per kWh are available, based on the type of efficiency measure and its estimated first-year savings. The program covers components such as lighting and controls, heating and ventilation equipment, chillers, variable speed drives, and other measures. To qualify, projects must be designed to perform at least 10% more efficiently than required by the Washington State Energy Code (WSEC). Facility operating conditions directly impact incentive levels. Post-facility-occupancy verification of measure performance is reviewed by the PUD before incentives are paid. The program was launched in 2007.

Sustainable Schools Program

In addition to the general new construction offering, the PUD provides school districts with technical assistance and funding support to design and construct highly energy-efficient school buildings. The PUD offers a whole-building approach and a component approach.

The whole-building approach applies to the integrated design and construction of structures and associated systems such as lighting, HVAC, building envelope, domestic hot water, and any other systems identified in the WSEC. The school district must establish a goal to install electrical systems that are at least 20% more efficient than code. Incentives begin at $0.30/sq. ft. for a 20% increase in efficiency over code to $1.40/sq. ft. for buildings that achieve a 50% reduction in energy use over code levels.

The component approach provides the school district with funding support when one or more individual systems achieves 20% greater efficiency than code or standard practice, as defined by the PUD. Technology options include ventilation, hot water systems, variable frequency drives, night cooling/flushing, indirect evaporative cooling, building commissioning, ground source heat pumps, day lighting controls, high-efficiency transformers, occupancy sensors, T-5 lighting fixtures, day lighting design, and higher insulation levels. Component systems are paid $0.20 per kWh based on the annual savings calculated by a PUD energy model. The program was launched in 2006.

Savings from the Commercial New Construction and Sustainable Schools programs in 2007 was 0.07 aMW. The 2008 energy savings goal for the combined programs is 0.22 aMW. The stretch goal is 0.24 aMW.

PowerTrend Online Tool

The objective of the PowerTrend Online Tool is to provide a customer with access to their energy consumption data, displayed in tables and charts. The original version of PowerTrend was offered to customers in 2000. It has been upgraded twice since the original, and the next version is pending a decision on the new Customer Information System (CIS). PUD staff can use PowerTrend to view residential or business customer usage to identify efficiency opportunities.

Conservation Voltage Reduction (CVR)

The PUD also obtains energy efficiency through its CVR program, which uses technology to lower distribution line voltages. National standards require utilities to operate distribution facilities within a margin of 114 volts to 126 volts. Most utilities operate their distribution delivery systems on the higher end of the range to accommodate the natural voltage reductions that occur over long distances. By reducing the voltage delivered to residences to 120 volts or lower, less energy is used by distribution transformers and household appliances without loss of performance. An evaluation of distribution efficiency efforts coordinated by the Northwest Energy Efficiency Alliance (NEEA) with input from the PUD and other regional utilities, shows that approximately 1% energy savings are possible for every 1%

average voltage reduction. About one-third of the savings is related to reductions in transmission and distribution losses and two-thirds of the savings comes from reduced use at the customer site.

To enable CVR, regulators and line drop compensation controls have been installed across the PUD's system. The program has been ongoing since 1988, with average savings per substation of about 800 MWh per year. Savings from work done between 2001 and 2006 was approximately 3.1 aMW. In 2007, additional projects resulted in savings of 0.9 aMW. The two phases of CVR will be fully complete in 2008, with additional savings of 0.04 aMW expected.

A third phase of CVR is under evaluation and would lower the average customer voltage by an additional 1% or 2%. It is estimated that the additional annual savings potential from CVR is approximately 3.5 aMW. To date, no significant system performance problems have been experienced as a result of the reduction in voltage at the substation, however, intelligent monitoring will be critical to managing the potential risk exposure that the next phase of CVR could present.

Northwest Energy Efficiency Alliance (NEEA)

NEEA is a regional, non-profit organization that has been working to encourage the development and adoption of energy-efficiency products and services in the Northwest for the past twelve years. The organization works in concert with the PUD and more than 100 other utilities in the Northwest to help transform markets in favor of energy efficiency. The PUD has historically been an active participant in NEEA policy and program efforts. Most recently, the PUD's Assistant General Manager (AGM) of Customer and Corporate Services was named Chairman of the Board.

The PUD provides funds directly to NEEA to support achievement of its goals and a portion of the savings achieved from NEEA's regional market transformation efforts are allocated to the PUD. In addition, BPA makes contributions to NEEA on behalf of the utilities they serve. Key initiatives of NEEA have included:

- Driving the market for CFLs—with almost 19 million bulbs being sold in the region in 2007, this makes the Northwest one of the highest CFL market shares in the nation;
- Laying the groundwork for energy-efficient technologies of the future including 80 PLUS power supplies, ductless heat pumps, small packaged commercial HVAC and industrial paper making sensors; and
- Changing the way commercial and industrial customers approach energy decision-making through efforts like BetterBricks™, that encourage energy-efficiency design, construction and operation of buildings.

In 2007, savings from the PUD's direct contribution to NEEA was 0.13 aMW. Savings attributable to BPA's contribution on PUD's behalf was 0.7 aMW.

Other Regional Conservation Efforts

Besides NEEA, the PUD is engaged in other regional conservation activities that focus on new technologies, delivery strategies, as well as energy-efficiency public policy. The PUD participates and provides financial support for market transformation efforts through the Consortium for Energy Efficiency (CEE) and the Electric Power Research Institute (EPRI). The PUD is a member of the Regional Technical Forum (RFT) and the Snohomish County Sustainable Development Task Force; it supports the Pacific Northwest Integrated Lighting Design Labs; and it participates in solar demonstration projects with the Bonneville Environmental Foundation (BEF). The PUD works with local utilities and other groups such as the Public Power Council (PPC) to promote energy efficiency. The PUD also participates in BPA's Utility Sounding Board and other regional collaboration efforts to advance regional conservations policies and practices.

Conservation Programs under Development

The PUD is in a continual process of expanding and refining its conservation portfolio to better meet the needs of customers, provide broader market coverage and improve cost-effectiveness. Specific programs under development include:

- A new construction program targeted at multi-family and mixed-use buildings;
- Additional prescriptive rebate options for commercial buildings that provide a streamlined participation option for small to medium commercial facilities;
- Audit options for residential and business customers to identify energy-efficiency opportunities;
- Education programs that provide customers the tools they need to manage their energy use; and
- Benchmarking tools to help customers compare their usage to regional averages and determine savings opportunities.

“Be a Conservation Sensation!” Theme

The PUD recently launched a multi-media marketing campaign to raise awareness and increase participation in its programs. The campaign encourages customers to “Be a Conservation Sensation.” It features customer testimonials in print, TV, and in radio ads; and is being incorporated into displays for tradeshows, neighborhood events, local festivals and street fairs. Response to date has been positive, by customers as well as employees.

Business Services Department

The PUD expanded the account management function for commercial customers in 2008 with the addition of four Account Managers for mid-size businesses. This adds to the existing staff of four Executive Account Managers that support large-size business customers. Together, these eight account managers will provide service to the PUD’s top 700 commercial and industrial (C&I) customers (approximately 80% of the total C&I energy used and one-half of all customer usage) with significant emphasis on the promotion of conservation.

Efficiency in PUD Facilities

The PUD is leading by example by evaluating energy consumption and identifying conservation potential within its facilities. While efficiency improvements have historically been incorporated throughout the PUD, a workgroup was formed in 2008 to more strategically identify and design a framework to guide conservation efforts. This framework defines a five-step process:

1) Assess current energy consumption;
2) Commit to conservation targets;
3) Develop a conservation plan;
4) Implement the plan; and
5) Capitalize on conservation achievements.

The workgroup has assessed energy consumption in PUD buildings and is using this data to benchmark performance against similar buildings nationwide. The benchmarking exercise has provided a basis for setting conservation goals.

PUD-Owned Generating Resources

Everett Cogeneration Project

The Everett Cogeneration Project, located at Kimberly-Clark Corporation's Everett pulp and paper facility, is owned by the PUD and operated under contract by Kimberly-Clark. The project was first commissioned in December of 1996. It has a 52 MW nameplate capacity rating and produces about 37 aMW per year. For the first 10 years of the project, the output was sold to the Sacramento Municipal Utility District (SMUD). Since October 1, 2007, the generation has been used to serve PUD loads.

Because the output is largely driven by mill operations and fuel availability (waste wood and black liquor), the project cannot be used to follow the PUD's load profile. The seasonal shape of the generation is relatively flat, with daily and hourly energy production that varies, sometimes significantly, with steam loads and fuel conditions.

While the project is considered a renewable resource by most definitions, it is not eligible as a renewable resource under I-937, because it was brought on-line prior to March 1999, and is owned by the PUD and not a customer.

The operating contract with Kimberly Clark expires in 2017. For planning purposes, staff assumes that the resource in its current form will not be available after that date.

Jackson Hydroelectric Project

The Jackson Hydroelectric Project is located on the Sultan River, north of the City of Sultan and is owned and operated by the PUD. The City of Everett is currently a co-licensee of the project, which expires in 2011, at which time the PUD will become the sole licensee. The City receives its water supply from Lake Chaplain, which the project feeds. The PUD receives all of the generation output from the plant. A significant activity for the PUD is relicensing the hydro project with the Federal Energy Regulatory Commission (FERC). The relicensing process is lengthy and slated for completion in May 2011.

The average annual energy supply from Jackson is about 45 aMW, with firm energy output at approximately 29 aMW. The nameplate capacity of the project is 103 MW. Power production is highest in the late fall through late spring periods due to precipitation and snowmelt. This output shape roughly matches the PUD’s seasonal load pattern. However, requirements to maintain stream flows, coupled with potable water supply, limits the project’s ability to follow load within a day. A significant uncertainty is the impact of future constraints that may be placed on the project as part of the FERC relicensing process.

Any improvements to Jackson that increase production without impounding or diverting additional water could be counted towards the state renewable portfolio standard.

Third-Party Contracts

The PUD currently has four long-term contracts for power supply. All but one of these contracts are tied to the output of specific generating plants. The PUD has no ability to shape deliveries under these contracts.

Market Contracts

In 2001, the PUD entered into an eight-and-a-half-year contract with Morgan Stanley Capital Group, Inc. for a 25 MW block of power. This contract will expire on December 31, 2009.

Klickitat PUD Power Purchase Agreement

In 1998, the PUD contracted with Klickitat PUD for 2.5 aMW of power from the Klickitat County landfill gas project. In 1999, the amount was increased to 5 aMW. The contract term ends May 31, 2009. The PUD has indicated to Klickitat that it would like to negotiate a continuing agreement.

The output of the resource comes in a relatively flat 5 MW block and has proven to be highly reliable. It qualifies as a renewable resource under I-937, and each megawatt hour is worth one Renewable Energy Credit (REC).[3] In May 2008, the PUD sold two-quarters worth of Renewable Energy Credits associated with the project for just under $55,000.

Hampton Lumber Mill Cogeneration

In 2006, the PUD negotiated a contract with Hampton Lumber Mills-Washington, Inc. for the electrical output of a cogeneration project located at Hampton's Lumber Mill in Darrington, Washington. The project utilizes wood waste to produce approximately 1 to 2 aMW of energy. The project began commercial operation in January 2007. The PUD has contracted

[3] For purposes of this IRP, the terms Renewable Energy Credit or REC refer to Washington state's Energy Independence Act (I-937) Final Rules definition: "Renewable energy credit" or "REC" means a tradable certificate of proof of at least one megawatt-hour of an eligible renewable resource where the generation facility is not powered by fresh water, the certificate includes all of the nonpower attributes associated with that megawatt-hour of electricity, and the certificate is verified by the renewable energy tracking system chosen by the department [CTED]."

for output through the tenth year of operation. The PUD has a first right option to purchase any Renewable Energy Credits associated with production.

White Creek Wind Project

In 2007, the PUD contracted with LL&P Wind, a wholly-owned subsidiary of Lakeview Light and Power, for the output of approximately 10% of the White Creek Wind Project, located in south-central Washington along the Columbia River Gorge. This share is equivalent to about 7 aMW of energy in an average year. The project began commercial operation in late 2007.

Since wind is an intermittent resource, another generation source of a readily dispatchable nature is needed to offset times when the wind is not blowing. The PUD contracted separately with BPA to provide a firming service to support the White Creek resource. Under this contract, BPA takes the output into its system and redelivers it seven days later in a flat scheduled block to a central Washington transmission hub.

Regional Transmission Contracts

The PUD relies on long-term transmission contracts with BPA to move power from generation sites to homes and businesses in Snohomish County. The PUD currently holds contracts for 1,618 MW of firm point-to-point capacity. These contracts include 16 different Points-Of-Receipt (where BPA will pick up power for the PUD) and six Points-Of-Delivery (where BPA will deliver power for the PUD). Of the 1,618 MW of capacity, 1,157 MW are designated for delivery to the PUD’s service territory. The remaining 461 MW are used to move power in the spring and summer when Slice power supplies exceed PUD loads. When the PUD needs more than 1,157 MW delivered to its service area, the staff formally asks BPA to “redirect” contract capacity to Snohomish County interconnection points. With one exception, BPA has always accepted these requests.

While the 1,618 MW of contract capacity is labeled “firm,” BPA is held to this amount only when all lines in the region are in service. The PUD regularly receives notices of transmission line deratings, especially during spring and fall maintenance periods. The PUD and others have been forced to take remedial actions, such as separating otherwise interconnected lines and increasing generation, to ensure all loads could be served. These conditions and concerns have prompted the PUD to request 350 MW of additional transmission capacity from BPA. It is not yet known how BPA will act on these requests.

4 PLANNING ENVIRONMENT

As the PUD plans how it will meet future load, it must consider the current and changing institutional framework in which it operates. These considerations include:

- The changing role of BPA;
- The newly enacted Washington State Renewable Portfolio Standard (I-937) and Integrated Resource Planning requirements (HB 1010);
- State and national climate initiatives;
- National energy policy legislation; and
- Transmission planning issues.

The Changing Role of BPA

In the late 1970s and early 1980s, BPA and other regional planners predicted a significant energy deficit (2,000 to 4,000 aMW) for the Northwest region. The anticipated shortage and consequent economic impacts gave rise to efforts to structure new energy legislation that would eliminate regional disagreement over the allocation of federal hydropower resources. The result was the Pacific Northwest Power Planning and Conservation Act (the Regional Act), which passed in 1980.

BPA's power supply role changed from that of simply a marketer of power from existing federal projects to that of a load and resource aggregator. The Regional Act imposed an obligation on BPA to acquire power to serve the loads placed on it by publicly-owned Northwest utilities, and to meld the cost of those acquisitions into the average cost of power sold. Along with this new responsibility came the additional tasks of protecting fish and wildlife and making a priority of conservation and renewables.

The power shortage predictions, however, proved to be wrong. BPA had energy surpluses for a significant period after passage of the Act. BPA had no need to acquire resources and, in fact, sold significant amounts of energy out of the region in the form of long-term contracts with California utilities. In 1995, however this began to change. A brief chronology is presented below.

The Regional Review

Deregulation efforts in other regions prompted governors of Washington, Idaho, Montana, and Oregon to convene a group to examine the future role of BPA (the Regional Review). Also at issue were BPA's rising costs and declining revenues, due largely to publicly-owned utilities reducing purchases from BPA in order to take advantage of lower market prices available in the late 1990s. The key conclusions of the Regional Review, published in 1996, were that the region should:

- Align the benefits and risks of access to existing federal power;
- Ensure repayment of the BPA debt to the U.S. Treasury with a greater probability than had previously existed; and
- Retain the long-term benefits of the system for the region.

From the Regional Review came the concept that "the mechanism proposed to accomplish these goals is a subscription system for purchasing specified amounts of power at cost with incentives for customers to take longer-term (15 to 20 year) subscriptions."[1]

The Subscription Process

Subsequent to completion of the Regional Review, BPA entered into a process with its regional stakeholders to implement the recommendations with new 2001 contracts. Out of that process, and in addition to the more traditional BPA products, came the Slice contract in which BPA sold a percentage of the power from federally-owned resources for a corresponding percentage of the cost. Further, BPA committed to selling power or providing financial benefits to Investor Owned Utilities (IOUs)[2] instead of paying Residential Exchange benefits as required by statute. BPA also committed to sales to Direct Service Industries (DSIs), which largely consisted of aluminum companies. The result of this process

[1] The Northwest Regional Review—Summary of Recommendations—Federal Power Marketing—the Bonneville Power Administration, Dec. 12, 1996.
[2] For loads up to 1,800 MW.

was a significant oversubscription of the BPA power system in the amount of some 3,000 aMW.

The 2000/2001 Price Run-up

Concurrent with the Subscription process, in 2000 and early 2001, the entire West Coast experienced unprecedented market price increases due largely to the failed California experiment in deregulated wholesale markets. These high market prices resulted in publicly-owned utilities placing load on BPA that had been previously removed. Given BPA's statutory obligation to serve and the commitments made to IOUs and DSIs, the agency was forced to purchase roughly 3,000 aMW of power from the high-priced and volatile market. The result was unprecedented BPA rate increases, with attendant adverse impacts on the Northwest economy and PUD customers.

These events caused BPA's operations to come under scrutiny by both federal and regional groups. Largely consistent themes emerged: the Northwest would be best served by limiting the role of BPA to being, once again, primarily a marketer of cost-based federal power. The Northwest Power and Conservation Council (NWPCC) summed up the prevailing view in its Fifth Northwest Electric Power and Conservation Plan:

> A sustainable role is defined for Bonneville in which it markets the existing Federal Columbia River Power System resources on an allocation basis, provides equitable benefits to the residential and farm customers of the region's investor-owned utilities, and meets additional load growth only through conservation and bilateral, incrementally priced contracts with individual customers or groups of customers.[3]

The Regional Dialogue

In response to these various recommendations, BPA began a regional dialogue process with its customers and other regional stakeholders. In July 2007, BPA published its Long-Term Regional Dialogue Policy Decision. The plan calls for allocating the cost of power from the

[3] Northwest Power and Conservation Council, Fifth Northwest Electric Power and Conservation Plan, page 9, May 2005.

federal power system to its publicly-owned utilities through a tiered rate construct. A utility will be allowed to purchase power from BPA's existing resource base at cost (Tier 1), in an amount equal to its share of load placed on BPA by all publicly-owned utility customers in 2010. BPA will no longer supply publicly-owned utilities at rates that meld the costs of existing resources with new resources. Rather, public utilities will be able to purchase power from the federal system up to a High Water Mark (HWM) level. Utilities may elect to purchase power from BPA above that amount at a rate reflecting BPA's cost to purchase the additional power (Tier 2). Alternatively, utilities may acquire power from other sources to serve their own loads above the HWM. In either case, publicly-owned utilities will face the cost of new resource acquisitions directly and ultimately be responsible for serving their own load.

The tiered-rate approach represents a significant paradigm shift. Regardless of whether they purchase power from BPA or acquire resources themselves, utilities will face the incremental cost of serving load growth. The new framework is supported by the region's utilities because it promises to:

- Reduce the price volatility associated with the output of the federal hydroelectric system;
- Increase the probability of BPA's ability to repay debt to the Federal Treasury;
- Reduce BPA's footprint in the market;
- Reduce tensions between IOUs and publicly-owned utilities with regard to the potential for public takeovers of IOU service territory; and
- Allow publicly-owned utilities to secure the benefits of the federal base system through long-term contracts.

Washington State Energy Initiatives and Legislation

Washington State's Renewable Portfolio Standard (I-937)

In the fall of 2006, voters of Washington state approved Initiative-937 (I-937) , requiring electric utilities with over 25,000 customers to accomplish all cost-effective conservation and, by 2020 use certain eligible renewable resources to serve at least 15% of loads. For the PUD, the 15% planning standard will require the acquisition of approximately 140 aMW of new renewable generation or Renewable Energy Credits. The legislation imposes significant penalties for non-compliance—$50 for every MWh the utility falls short of the goals. I-937 requires utilities to:

- Estimate the cost-effectiveness of conservation programs using methodologies consistent with NWPCC approaches;
- Utilize the NWPCC's 5th Power Plan to gauge regional pro-rata shares of achievable conservation potential;
- Beginning January 1, 2010, and every two years thereafter, calculate and document 10-year conservation potential;
- Produce detailed analyses of how energy will be conserved through end-user programs, production and distribution efficiencies, co-generation, and/or distributed generation;
- Use eligible renewable resources to serve 3%, 9% and 15% of utility loads by 2012, 2016 and 2020, respectively; and
- Beginning January 1, 2012, report yearly compliance with the laws requirements.

The PUD has joined the Western Renewable Energy Generation Information System (WREGIS), which will enable it to track Renewable Energy Credits and provide proof of I-937 compliance. WREGIS is an independent registry and tracking system that provides certificate-based accounting for environmental attributes associated with renewable energy. One certificate is created for each megawatt-hour of renewable energy produced. Certificate holders can use WREGIS accounts to comply with individual state renewable portfolio standards or voluntary green programs. For compliance purposes, I-937 renewable targets can be met only using Renewable Energy Credits earned during the target year, one year before and one year after. If the PUD has Renewable Energy Credit surpluses it cannot use for compliance, it plans to sell them to fund renewable energy research and development.

Washington State Integrated Resource Planning Requirements (ESHB 1010)

In March 2006, the Washington State Legislature passed into law Engrossed Substitute House Bill 1010, which adds a new chapter to Title 19 RCW requiring electric utilities with more than 25,000 customers (that are not full requirements customers of BPA) to develop an IRP by September 1, 2008. Each utility must report on its progress every two years, and update its plan every four years. At a minimum, the IRP must include:

- A range of forecasts, for at least the next 10 years, of projected customer demand that takes into account econometric data and customer usage;
- An assessment of commercially available conservation and efficiency resources;
- An assessment of commercially available, utility scale renewable and nonrenewable generating technologies;
- A comparative evaluation of renewable and nonrenewable generating resources, including transmission and distribution delivery costs, and conservation and efficiency resources using “lowest reasonable cost” as a criteria;
- The integration of the demand forecasts and resource evaluations into a long-range assessment describing the mix of supply-side generating resources and conservation and efficiency resources that will meet current and projected needs at the lowest reasonable cost and risk to the utility and its ratepayers; and
- A short-term plan identifying the specific actions to be taken by the utility consistent with its long-range integrated resource plan.

The governing body of a consumer-owned utility, such as the PUD, shall hold public hearings before approving plans. The Department of Community, Trade, and Economic

Development (CTED) will aggregate the data, prepare an electronic report for the Legislature, and assess the overall adequacy of Washington's electricity supply.

Washington State Emissions Performance Standards (SB 6001)

The recently enacted Washington State Senate Bill 6001 requires the Governor to develop policy recommendations for achieving specific greenhouse gas (GHG) reduction targets: 1990 emission levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050.[4] Beginning in 2010, The Department of Energy (DOE) and CTED must begin reporting the total GHG emissions in Washington state.

One provision in particular involves power supply contracts of five years or more that are entered into after July 2008. Generation sources underlying these contracts must comply with a permissible ceiling of 1,100 pounds of GHG emissions per megawatt-hour (or the average available GHG emissions output as derived by CTED's analysis of appropriate combined cycle combustion turbines). Some emissions are allowable if sequestered or mitigated under a plan approved by the Energy Facilities and Site Evaluation Council (EFSEC). By June 2008, the DOE, EFSEC, CTED, and BPA must coordinate and adopt rules to implement and enforce standards. All stakeholders will participate in discussions on what impacts the new rules may have on reliability and overall consumer costs in the Northwest.

State, Regional and National Climate Initiatives

The Washington Climate Change Challenge

In February 2007, Washington state Governor Christine Gregoire signed Executive Order No. 07-02 in order to establish goals for reductions in climate pollution, to increase energy related jobs and to reduce expenditures on imported fuel. The Washington Climate Change Challenge directed the Directors of Ecology and CTED to assign members to specific areas of concern: transportation, forestry, energy, and agriculture sectors. These Technical Work

[4] The 1990 benchmark was chosen because it corresponds to the date when many nations signed the Kyoto Accord.

Groups (TWGs) met throughout 2007 and into 2008 to consider the full range of policies and strategies that would be needed to achieve the goals established by the Governor.

The energy sector was considered by both the Energy Supply TWG and the Residential, Commercial and Industrial Efficiency TWG. In December 2007, both TWGs submitted an extensive list of high priority mitigation recommendations to address GHG emission reductions. Each set of recommendations may directly or indirectly affect the PUD over the long-term. The PUD's Climate Change Policy, issued in March 2007, has already moved the utility forward on many of these issues.

The Energy Supply TWG recommendations centered on several key points:

- Offer incentives to encourage renewable energy development;
- Investigate efficiency improvements at existing renewable and power plants;
- Ramp up technology research and development (R&D) and technology-focused initiatives;
- Study carbon dioxide capture, storage and reuse (CCSR) incentives, requirements, enabling policies, and advanced R&D.

The Residential, Commercial and Industrial Energy Efficiency and Conservation TWG prepared a long list of recommendations, some of which were to:

- Create demand-side management, energy-efficiency programs, funds and goals for natural gas, propane, and fuel oil;
- Create targeted financial incentives and instruments to encourage energy-efficiency improvements (business energy tax credit and private/public efficiency funds);
- Plan promotions and incentives for improved community planning and improved design and construction (third-party sustainability, green and energy-efficiency building certification programs) in the private and non-state public sectors;

- Reduce barriers and provide incentives and resources to promote and implement combined heat and power (CHP or co-gen) and waste heat capture, including net metering for combined heat and power;
- Implement consumer education programs, including labeling of embodied life-cycle energy and carbon content of products and buildings;
- Apply more stringent appliance, equipment, lighting efficiency standards as well as appliance and lighting product recycling and design;
- Address policies and/or programs specifically targeting non-energy related GHG emissions (methane, aluminum and cement production, hydro fluorocarbon and perfluorocompounds, and other key process gases). Also, confront sulfur hexafluoride (SF_6) emissions used in electricity transmission and distribution insulation.

PUD staff continues to monitor these recommendations to assess how each will affect the utility in regards to energy resources, regulatory reporting, financial liability, and opportunities for regional leadership.

Western Climate Initiative

The Western Climate Initiative (WCI) is a collaboration that was launched in February 2007 by the Governors of Arizona, California, New Mexico, Oregon and Washington to develop regional strategies to address climate change. WCI is identifying, evaluating and implementing collective and cooperative ways to reduce greenhouse gases in the region. In the spring of 2007, the Governor of Utah and the Premiers of British Columbia and Manitoba joined the Initiative. Montana joined in January 2008 and Quebec moved from Observer to Partner status in April 2008. Other U.S. and Mexican states and Canadian provinces have joined as observers.

Through WCI, the partners have set an overall regional goal of reducing greenhouse gas emissions to 15% below 2005 levels by 2020. By August 2008, the partners will complete the design of a market-based mechanism to help achieve that reduction goal. The partners developed a work plan to guide their efforts and are seeking public input throughout the process. Snohomish PUD is actively involved as a stakeholder in the WCI process and has provided comments that are instrumental to its continued work.

Federal Carbon Initiatives

Emissions of greenhouse gases and their connection to global climate change is currently the most pressing environmental issue before the utility and the industry as a whole. In the 110th Congress, addressing climate change has become top priority. As the PUD plans for the future, several recent and pending federal legislative actions will come into play.

They include:

- S. 1766—the Low Carbon Economy Act of 2007 introduced by Senators Jeff Bingaman (D-NM) and Arlen Specter (R-PA), which provides for a cap-and-trade program beginning in 2012;
- S. 2191—America's Climate Security Act introduced by Senators Joseph Lieberman (I-CT) and John Warner (R-VA). It creates a greenhouse cap-and-trade program with reduction mandates by 2020 and 2050;
- Creation of the Select Committee on Energy Independence and Global Warming;
- Omnibus Appropriations bill for FY 2008, which requires EPA to develop rules for reporting of greenhouse gas emissions; and
- Possible post-Kyoto Protocol framework to curb greenhouse gas emissions.

Staff continue to monitor these federal actions to ensure the utility can respond appropriately to future legislative action.

National Energy Policy Legislation

The Energy Policy Act of 2005

In March 2005, Congress enacted the Energy Policy Act of 2005. This far-reaching piece of legislation will impact the electric utility industry by providing funding for new developments in the areas of energy efficiency, renewable energy, oil and natural gas, clean coal technologies, nuclear, vehicle technology and fuel use, hydrogen, and electricity. Of particular interest are:

- Required reductions in consumption and mandates for renewable energy use in federal buildings;
- Funding for low-income housing initiatives;
- Reauthorization of the Renewable Energy Production Incentive (REPI) program;
- Funding for increased efficiency at existing hydroelectric projects;
- Provision of funding for advanced vehicles and hybrids that could move load from gas to electric power; and
- Direction to FERC to promote investment in critical transmission capacity and efficiency, along with implementation of reliability measures.

The Energy Independence Act of 2007

The Energy Independence Act of 2007 was signed into law by President Bush in December 2007. The act amends the Energy Policy Act of 2005 with the following key energy related areas:

- Increased production of biofuels;
- Improved standards for appliances and lighting;
- Energy savings in buildings and industry;
- Energy savings in government and public institutions;
- Accelerated research & development of solar, geothermal, ocean, and storage technologies;
- Carbon capture and sequestration;
- Energy transportation and infrastructure; and
- Smart grid management and technologies.

While not affecting the PUD’s day-to-day operations, these initiatives represent possible funding opportunities for PUD research efforts and over the long-term, promise to move the electric utility industry away from its past dependence on fossil fuels.

Transmission Planning Issues

FERC Order 890

FERC order 890, first issued in 2006 and later revised in December 2007, affects the way transmission is planned by the electric utility industry. Its goal is to prevent discrimination by owners of transmission facilities against utilities and power producers desiring transmission service. Order 890 strengthens the Open Access Transmission Tariff (OATT) standards, reduces opportunities for the exercise of market power, makes it easier to detect abuses, facilitates enforcement efforts, and increases transparency in the areas of planning and transmission system use.

The aspects of Order No. 890 that address OATT modifications have little direct impact on the PUD since it does not provide transmission services to others. However, the nine planning principles adopted in the order do benefit the PUD. These include:

- Coordination
- Openness
- Transparency
- Information exchange
- Comparability
- Dispute resolution
- Regional participation
- Economic planning studies
- Cost allocation for new projects

As a transmission-dependent utility, the PUD actively participates in regional planning forums. In addition to ColumbiaGrid, these include the Western Electricity Coordinating Council (WECC) and the Northwest Power Pool (NWPP).

NERC Reliability Compliance

Outages of major transmission lines in both the Western and Eastern U.S. have led to legislation and regulation of electric reliability at the federal level. In March 2007, FERC issued Order No. 693, which addresses mandatory reliability standards for utilities. The National Electric Reliability Council (NERC) was tasked with developing reliability standards for all utilities and for ensuring those standards are met. All users, owners and operators of the bulk power system have been required to identify the functions that they perform and register the information with NERC or their regional reliability organization. In the PUD's case, this is the WECC. The rules include significant economic penalties for non-compliance. The PUD has created a cross-functional compliance team to deal with reporting requirements and implementation of new procedures called for by the WECC and NERC.

Regional Planning

Beginning in the early 1990s with "IndeGO" and continuing through the present, there have been numerous efforts to change the way the regional transmission system is planned and managed. One recent attempt sought to apply FERC's Standard Market Design concept. This model would have imposed national requirements for transmission management and pricing in a one-size-fits-all manner that did not recognize the unique characteristics of the particular regions. Fortunately these types of efforts, with their potential for uncontrolled costs, independent governance structures (outside of any form of local control) and unknown consequences, have consistently failed.

In 2006, a new transmission planning group was formed by Northwest utilities, called ColumbiaGrid. ColumbiaGrid is composed of major private and public utilities, including the PUD, with a common interest of developing solutions that work and expanding transmission where it makes sense.

ColumbiaGrid has completed its first draft biennial transmission plan. It is hoped that this cooperative effort will identify and bring to fruition necessary transmission facilities over the next 10 years. The planning process has been open, transparent and designed to promote consensus among involved entities. Facility agreements will be signed by the affected utilities to provide for the funding and construction of needed projects.

Growing Transmission Constraints in the Northwest

The federal transmission system in the Northwest was originally sized to deliver BPA hydroelectric power and the output of five nuclear plants. For many years, this meant surplus transmission was available, but this is no longer the case. In addition to moving power to loads, the system is now used to transfer significant amounts of energy. As a result, the transmission capacity in the Northwest is becoming increasingly constrained and, at times there is more traffic than existing facilities can securely carry.

Curtailments in the Puget Sound area were nearly non-existent prior to April 2003, when Canadian treaty power returns were increased from 630 MW to 1,149 MW. Since that time, warnings of curtailments on the Northern Intertie (which runs through the I-5 corridor) have become regular occurrences. These warnings generally occur on cold winter days, and when transmission line maintenance reduces the amount of available capacity. To avoid shedding load, Puget Sound utilities have worked together quickly to change electrical flows by adjusting scheduled output from local power plants.

A sub-committee of the NWPP called the Puget Sound Area Study Group (PSASG) has been studying the problem. Reports completed in 2005 and 2007 found that dispatching Puget Sound area generating plants (out of economic order) significantly improved Northern Intertie transfer capabilities.

Simultaneously, BPA has been working on “redispatch” pilots for four transmission paths. Preliminary results show it costs little to pay generators to increase output when lines become constrained as compared to the economic consequences of cutting loads. In December 2007, BPA implemented a redispatch program for the Puget Sound. The program uses price bids to incent generators to increase or decrease output and thereby eases Northern Intertie operating constraints.

While the Puget Sound resdispatch program is helpful, it will not provide enough relief to avoid outages over the long-term. New transmission infrastructure will be needed to maintain electric reliability.

5 ANALYTICAL FRAMEWORK

The development of an Integrated Resource Plan (IRP) involves seven broad steps:

- Scenario creation;
- Load forecasts;
- Avoided cost forecasts;
- Conservation evaluations;
- Power supply cost and opportunity assessment;
- Portfolio development and analysis; and
- Plan recommendation and documentation.

Scenarios and load forecasting are described in Section 2. This section addresses the analytical framework used to evaluate conservation, power supply options and avoided costs. It also outlines factors that influence the design of resource portfolios.

Evaluating Conservation and Energy-Efficiency Potential

The process the PUD follows to identify conservation resources that are technically feasible, economic and achievable parallels that used by the Northwest Power and Conservation Council (NWPCC) and most other utilities. Staff began by identifying all conservation savings that could be theoretically captured, if economics and market barriers were not considered. From there, each potential measure was evaluated for cost-effectiveness. Those found to be economic were further evaluated to determine the level of savings that could be practically achieved, given current technology and market conditions.

Estimating Technical Potential

The first step in conservation assessment involves estimating technical potential. This consists of creating a forecast where all possible energy-efficiency measures are installed, and then subtracting the forecast from a baseline to calculate savings by end-use, building type and sector.

Four alternatives to the baseline were considered, reflecting these resource categories:

- Equipment in existing construction;
- Retrofit measures in existing construction;
- Equipment in new construction; and
- Shell and plumbing upgrades in new construction.

For each of the equipment scenarios, efficiency shares were shifted from the baseline assumption to 100% efficiency. In effect, equipment added in new construction or replaced upon burnout was shifted to the highest efficiency. For non-equipment measure scenarios, the baseline consumption for a given end-use was revised across all efficiency levels.

The impacts of each potential conservation measure is a function of the expected costs, savings, life of the measure, and the number and variety of end-uses to which the measure can be applied.

Measure Savings
Estimates for the energy savings of a measure were based on engineering calculations, PUD case studies and other evaluation studies, Regional Technical Forum (RTF) data, and secondary sources such as the California Database of Energy Efficiency Resources (DEER).

Measure Costs
The cost of installing a measure was derived from merchant websites (Lowes, Home Depot, Sears, Trane, etc.), the DEER database, RS Means,[1] and previous PUD studies.

Measure Life
Manufacturer data, RTF, DEER database and previous studies were used to estimate the expected lifetime of a measure.

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[1] RS Means is a widely used reference tool and database for estimating construction costs.

Measure Applicability

Measure applicability is a general term that encompasses a number of factors, including the technical feasibility of installation and the current or naturally occurring saturation of the measure. It includes factors that are used to allocate savings associated with mutually exclusive measures. The impacts of federal energy codes and standards and the small penetration of high-efficiency equipment that occurs without market intervention was also considered in measure applicability.

Table 5-1

Conservation Data Sources

	Data Element	Description	Sources
All Measures	Fuel Saturation	The percentage of customers that use a particular fuel (gas or electric) in the PUD's territory for the specific end-use (e.g., water heat, space heat, etc.).	Residential-RES Hebert Research, Snohomish PUD Inventory, Commercial-CBSA, and Snohomish PUD Commercial Market Assessment
	End-Use Saturation	The percentage of customers that have the specific end-use.	Residential-RES Hebert Research, Snohomish PUD Inventory, Commercial-CBSA, and Snohomish PUD Commercial Market Assessment
	Measure Share	Used to distribute the percentage of market shares for competing measures such as heat pumps vs natural gas heaters.	Engineering Judgment and Secondary Data Sources
	Measure Incomplete Factor	Represents the percentage of buildings that do not have the specific measure currently installed.	Snohomish PUD EE Program Data Tracking Systems, and Engineering Judgment
	Technical Feasibility	Accounts for the percentage of buildings that can physically install the measure. Factors that may affect this percentage include whether the building already has the baseline measure (e.g., dishwasher), as well as limitations on installation (e.g., size of unit and space available to install the unit).	Secondary Data Sources and Engineering Judgment
	Measure Interaction	This accounts for additional heating required by the HVAC system because of a reduction in heating produced by more energy-efficient lighting	Energy Simulation Modeling (eQuest) and Engineering Judgment
Emerging Technology (ET) Measures and Those Measures Competing w/ET	Year Introduced	Shows the year that the measure is expected to be commercially available.	ACEEE 2004 and Engineering Judgment
	Initial Share	Shows the initial impact of the measure in a percentage of the market acceptance of the emerging technology measure.	ACEEE 2004 and Engineering Judgment
	Year of Final Share	The relationship between the initial year introduced and year 20 is assumed to be a linearly increasing function for ET measures.	ACEEE 2004 and Engineering Judgment
	Final Share	This factor takes into account increasing market acceptance for the ET measure.	ACEEE 2004 and Engineering Judgment

Where there is only one measure that affects an end-use, the percentage adjustment is simply the measure's savings. However, in nearly every instance, there are multiple measures that affect end-uses, so a specific methodology must be used to assess the cumulative and interacting impacts.

The equation below shows the basic calculation for estimating savings for single retrofit or new construction measures. The savings are defined as the changes in annual consumption associated with a particular end-use, where other customer assets remain constant. An example is insulation for existing or new buildings. The insulation reduces consumption without changing the basic HVAC equipment in a building.

$$SAVE_{ijm} = EUI_{ije} * PCTSAV_{ijem} * APP_{ijem}$$

where:

SAVEijm = annual energy savings for measure *m* for end use *j* in building type *i*;

EUIije = calibrated annual end-use energy consumption for the equipment configuration *ije*;

PCTSAVijem = the percentage savings of measure *m* relative to the base usage for the equipment configuration *ije*, and takes into account interactions among measures such as lighting and HVAC calibrated to annual end-use energy consumption;

APPijem = a fraction that represents a combination of different factors that determine a measure's overall applicability, including the technical feasibility, existing measure saturation, end-use interaction, and any adjustments needed to allocate savings with other mutually exclusive measures.

In almost all situations, however, a single end-use is affected by many different measures. The assessment of cumulative impact needs to account for the interaction among the measures. A process called measure stacking is used to establish a rolling, reduced baseline that is applied iteratively as measures are sequentially assessed. This is shown in the following equations:[2]

$$SAVE_{ij1} = EUI_{ij\,e} * PCTSAV_{ije1} * APP_{ije1}$$

$$SAVE_{ij2} = (EUI_{ije} - SAVE_{ij1}) * PCTSAV_{ije2} * APP_{ije2}$$

$$SAVE_{ij3} = (EUI_{ije} - SAVE_{ij1} - SAVE_{ij2}) * PCTSAV_{ije3} * APP_{ije3}$$

[2] Measures 1, 2 and 3 refer to end-use life.

The result of this process is that a measure's absolute savings as part of a bundle of measures is less than its savings on its own. Because the order in the stack has an effect on the absolute savings, measures were applied according to the ascending levelized cost of each measure. This ensured that the most cost-effective resources were incorporated first.

Determining Economic Potential

Economic potential represents a subset of technical potential and includes only those measures that are deemed cost-effective based on a societal Total Resource Cost (TRC) test criterion. For each measure, the test is structured as the ratio of the net present values of the measure's benefits and costs. Those measures with a benefit-to-cost ratio of equal or greater than 1.0 are deemed cost-effective. That is, for each measure, we have:

$$\frac{\text{Societal Benefits}}{\text{Societal Costs}} \geq 1$$

Benefits include the value of avoided energy costs, avoided regional transmission costs, investment in local distribution avoided line losses, and the conservation credit granted by the Northwest Power Act. In order to capture the seasonal and time-differentiated impacts of each measure, a unique hourly benefit profile was calculated for each measure as the product of the measure's hourly end-use load shape and hourly-avoided costs. This approach produces a unique benefit level for each measure. The measure costs include the total installed cost of the measure and the applicable operation and maintenance costs (or savings) associated with ensuring proper functioning of a measure over its expected life.

Table 5-2

Economic Potential Analysis

Benefit Components	Cost Components
▪ Avoided hourly generation (energy) costs ▪ Avoided line losses ▪ Avoided regional transmission capacity ▪ Avoided transmission system expansion costs ▪ Avoided distribution costs ▪ NW Regional Conservation Credit (10%) ▪ Where applicable, cost of renewable energy credits	▪ Measure capital costs ▪ Installation labor costs ▪ On-going O&M costs ▪ Additional “other” costs

Three important considerations must be kept in mind when interpreting the results of economic screening. First, the analyses are based on a TRC perspective, and as such, no conclusions can be drawn about how costs will accrue to the utility or participants. This consideration has important implications in terms of achievable potentials because in most conservation programs, the utility seldom pays the full incremental cost of the measure.

Second, the outcomes of the screening procedure depend on assumptions that will likely change over time. Measure costs, for example, are likely to decline as the demand for energy efficient technologies rises. As avoided costs change, so do the value of savings resulting from the installation of energy efficient technologies. A measure failing the economic screen in earlier years of a planning period may become cost effective in later years if avoided costs increase.

Third, the economic analysis is based on assumptions intended to reflect typical customers. This means that while a measure might not pass the economic screen within the context of the study, there could well be instances for some customers where the measure would be economical. This is especially true in the commercial and industrial sectors, where custom incentive programs allow analysis of unique customer characteristics that may support cost-effectiveness in a particular application.

Determining Achievable Potential

Achievable potential is that portion of economic potential that can be practically captured over the planning horizon. Developing accurate estimates of achievable conservation levels is a critical element in resource planning. Understating achievable potential results in lost opportunities. On the other hand, if overstated, there will be gaps in a utility's ability to meet load growth.

Unfortunately, there are no standard methods for predicting actual levels of achievable potentials. The NWPCC has historically assumed that 85% of the estimated economic potential is likely to be achievable. This figure is somewhat controversial. It is based on a single project, the Hood River Weatherization Pilot Project that took place in the early 1980s. The pilot explored customer participation when weatherization measures were funded at 100%. Many analysts feel the program is not indicative of typical utility service areas, or funding levels. Even so, it is viewed as the gold standard for identifying achievable potential.

In practice, the amount of cost-effective conservation that may be assumed achievable depends on several factors, including customers' willingness to participate (which is itself a function of the incentive levels offered), utility rates, constraints that may prevent a customer from participating, and opportunities that may encourage participation. It is difficult to identify all such factors and to quantify their likely impacts without rigorous, systematic and longitudinal market studies.

For this analysis, staff assumed that 85% of the economic potential in existing buildings and 65% of new construction and equipment replacement markets could be achieved over the next 20 years. The lower figure in the new construction market is due mainly to limited "windows of opportunity" for equipment purchase decisions. Economic viability of investments in efficient equipment varies with the type and timing of construction activity. Although conservation resources in the new construction markets may be available at a lower cost than in retrofit markets, the utility must synchronize its efforts with the normal cycle of new construction and equipment replacement activity. These efforts involve developers, architectural and engineering firms, as well as customers.

Achievable potential levels serve as planning guidelines. Ultimately, realizing demand-side opportunities depends on the market potential for energy efficiency, which is influenced by some factors that are beyond the PUD's control. These include the customers' willingness and ability to participate, administrative constraints, and availability of effective delivery infrastructures. Actual experience implementing programs may cause the PUD to consider alternative strategies for capturing these resources.

Avoided Cost Forecasts

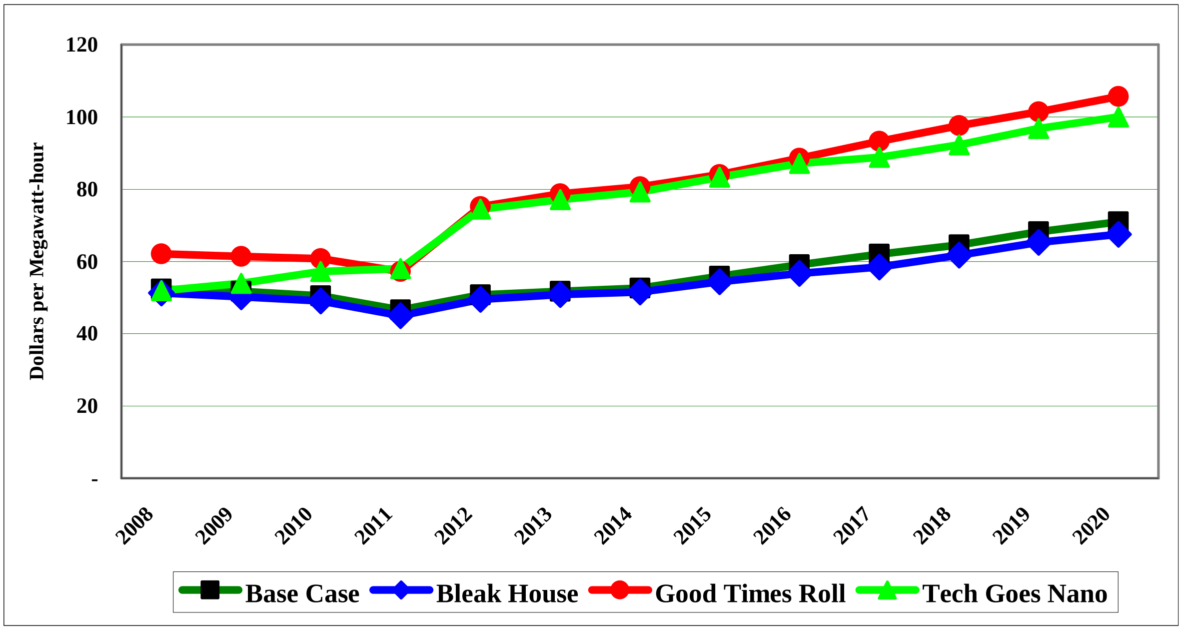
Because they measure cost-effectiveness, avoided cost forecasts are an important driver of conservation program analysis. Avoided costs are defined as the costs a utility would incur in the absence of a particular program or measure. For analysis purposes, avoided costs associated with power supplies can be estimated using forecasts of wholesale power prices. The rationale for this approach is that a kilowatt-hour saved through a conservation program frees up power a utility can sell in the wholesale market; or conversely enables the utility to avoid a wholesale power purchase it would otherwise need to make. Thus, the market can be used as a benchmark for valuing demand-side program benefits.

Avoided costs associated with transmission and distribution activities are based on the avoided costs for regional transmission services and on the levelized cost of new capital investment in delivery infrastructure. These benefits assume that over the long-term, conservation programs will enable the PUD either to defer investment for a period or reduce the size of future lines.

To develop market price forecasts, staff relied on output from a computer simulation model known as Aurora. This model was developed by EPIS, Inc. and is widely used by Northwest utilities (including BPA, NWPCC, Avista, Seattle City Light, and PSE). Aurora captures the interaction of supply and demand dynamics on the West Coast to determine power market prices at major power trading hubs. Staff defined input assumptions associated with each scenario and obtained outside expertise to run the model.[3] The results are shown below in Figure 5-1.

Figure 5-1

Regional Electricity Prices by Scenario



The forecast of power prices for the Base Case begins at $52.33 per MWh, declines slightly to $46.55 per MWh in 2011, and then begins a steady rise of roughly 4.9% a year. This forecast pattern is nearly identical to the Bleak House scenario where the economy enters a long-term recession. The other two scenarios, Growth and Consequences and Tech Goes Nano,[4] show significantly higher power prices in 2012 and beyond, exceeding $100 MWh by the year 2020. Staff concludes from these results that the potential for market prices to fall below current Base Case expectations is small.

The avoided cost calculations described above follow the same approach used by NWPCC and prescribed by I-937. However, because these figures represent forecasts of short-term

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[3] The PUD has acquired the Aurora model from EPIS, Inc., which will enable staff to conduct this analysis in-house in the future.

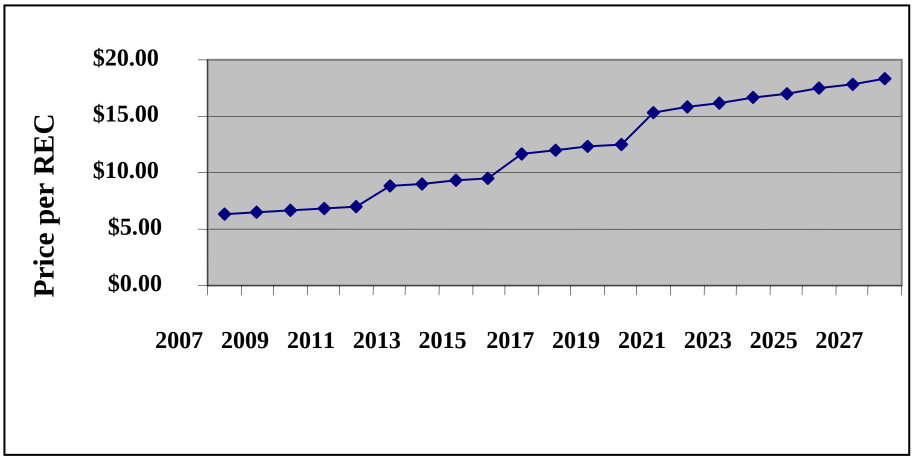
[4] See Section 2 and Appendix C for a complete description of the Base Case and individual scenarios.

power markets, they are not wholly consistent with the PUD's preference for renewable resources or the fact that the PUD will need to make long-term power supply commitments to serve future loads.

To address the renewable concern, staff developed a second set of avoided costs by forecasting prices for Renewable Energy Credits and adding these increments to the hourly wholesale prices produced by the Aurora model. These "green avoided cost adders" are shown below for the Base Case.

Figure 5-2

Renewable Energy Credit Price Forecast 2007—2027



Projected costs of Renewable Energy Credits are based on actual costs in 2007. Renewable Energy Credits are currently sold to support voluntary renewable markets in Washington—programs like PUD's Planet Power. The average nationwide cost of Renewable Energy Credits in 2007 was approximately $6.29. Future costs are estimated by applying a 2.5% inflation rate and expected cost escalation as I-937 requirements come into effect as shown in the table below.

Table 5-3

Renewable Energy Credit Price Escalation

Year	Renewable Energy Requirement (% of Total Load)	Expected REC Cost Escalation
2012	3%	25%
2016	9%	20%
2020	15%	20%

An alternative approach would be to identify a single resource or a set of power supply resources in the PUD's plan that could be deferred or reduced in size as a result of conservation efforts. Once identified, the capital and operating costs associated with these resources could be used to measure the potential benefits of proposed programs. While this approach has merit conceptually, it does not produce time-differentiated value profiles: the resulting avoided costs are the same in every hour of the year. As a result, programs that reduce energy use during on-peak hours would be ranked the same as programs reducing off-peak energy. Yet, we know that programs targeting winter on-peak loads are the most valuable because the demand for electricity in the winter drives the PUD's need for new power supplies.

Another problem with this approach involves the need to meet legislated renewable portfolio standards. By 2020, the PUD will need approximately 140 aMW of new renewable resources to meet the law's 15% target. Because this requirement cannot be deferred or avoided, the costs associated with the PUD's supply-side resource plan do not provide a particularly good benchmark for evaluating conservation benefits.

Staff will continue to study these issues and work with NWPCC and other technical planning groups on alternative methods for estimating avoided costs. In the meantime, staff has used the NWPCC methodology to identify cost-effective conservation goals for the IRP. It has used the "green" avoided cost estimates to measure conservation stretch goals—that are not subject to penalties under I-937 if savings are less than forecasted.

Resource Portfolio Development and Design Considerations

After the achievable conservation was identified, staff developed resource portfolios for each load forecast and scenario by adding power contracts or generating units to meet load or I-937 shortfalls. The power supply options were added in priority order based on availability, cost and operational consideration. Once the portfolios were developed, staff used a model that was developed in-house to identify the costs associated with each plan. Staff analyzed lead-times and implementation issues. From this review, a single preferred plan emerged.

Reliability Considerations

The Puget Sound area is becoming increasingly vulnerable to outages due to limited transmission capacity from east to west over the Cascades and south to north along the I-5 corridor. Under high demand conditions (caused by an arctic pattern, for example), there is an increasing likelihood that BPA would need to drop loads in Snohomish County to maintain reliable operations on other parts of its transmission network.

While the appropriate solution would be to add transmission infrastructure, there are no major improvements planned at this time. Decisions about regional transmission issues are not under the PUD’s control and construction of physical assets can often take years. As such, resource options that are located within the PUD’s service territory, and thereby reduce the PUD’s reliance on regional transmission, are preferred over those located across the state.

Matching Load

The PUD must precisely match power supplies to load at all times. PUD staff manages supply from one hour to the next by changing the amount of energy scheduled into and out of the PUD’s system. The PUD relies on BPA to respond to load changes within an hour. Automatic generation control (AGC) equipment at federal power plants receives signals every four seconds that increase or decrease generation as loads vary.

As intermittent wind generation becomes a bigger part of the region’s resource mix, scheduling and other system control functions will become increasingly difficult for both

BPA and the PUD. It is not known how much increased variability the regional hydroelectric system can absorb given existing fish protection, recreation and other river obligations. There are limited resources outside of the federal hydro system for load regulation and most of these are expensive to operate. For PUD resource planning, wind generation needs to be paired with a companion resource or a contract that can react quickly to changes in its output.

Environmental Concerns

Another important portfolio goal for the PUD is to find a balance between meeting load at an acceptable cost and minimizing impacts on the environment. Whether regulated or not, every resource choice carries with it some discernable impact on nature. Some of these impacts can be quantified, such as tons of CO_2 emitted, while some cannot and are subjective, such as the aesthetic impacts of resource types and site choices. Regardless, each of these impacts must receive consideration.

As stated in the PUD's Climate Change Policy adopted in 2007, the PUD's strategy is to utilize integrated resource planning standards that consider the long-term costs and risks associated with greenhouse-gas-emitting generation sources; and to consider a diversity of resource options that provide the optimum balance of environmental and economic elements. The PUD has publicly stated its desire to meet future growth in electricity demands with conservation and renewable energy.

Forecast Risk

For any portfolio there is a risk that the future may not unfold as envisioned and the choices made will turn out to be more or less costly than expected, will be more or less useful for serving load, or will result in unexpected consequences. Some areas of risk that the PUD must consider include:

- Expansion or contraction of the local economy that could cause loads to be higher or lower than anticipated or that change load shapes. For instance, depending on market acceptance, plug-in hybrid cars could flatten daily load profiles;

- Changes in technology that make some investment choices obsolete or make others more attractive;
- Fuel price volatility; and
- Changes in federal, state or local regulations that affect the cost or operational aspects of generation resources.

While it is impossible to eliminate risk, there are techniques for managing it, for example:

- Limiting exposure by making bite-size commitments to meet near-term requirements. These can be in the form of small resource developments or numerous small contracts with staggered terms;
- Sharing investment in new resources with other utilities;
- Acquiring sites and installing infrastructure in advance of expected need to allow for acceleration of construction if circumstances warrant;
- Locating generation close to load centers to reduce exposure to changes in transmission availability and cost; and
- Proactively searching for and monitoring resource opportunities (both supply and demand) that may not look cost-effective today, but may become appropriate if conditions change.

6 RESOURCE OPTIONS

Resources available to meet future load growth fall into three broad categories: conservation programs, power supply contracts and PUD-owned generation. This section outlines these options and briefly describes transmission projects being considered in the region.

Conservation Resources

By reducing the demand for electricity, conservation programs lower PUD costs, decrease exposure to volatile power market prices, and defer the need for new transmission and distribution capacity. For these and other reasons, it is the resource the PUD looks to first to meet future load growth.

The PUD has been actively engaged in energy-efficiency programs for the past two decades. Since 1980, the PUD has acquired over 86 aMW of conservation resources. Given economic growth in the PUD's service territory, conservation will continue to play a critical role.

Energy-Efficiency Potential

The term energy efficiency means using fewer kilowatt-hours without degrading the end-uses that electricity enables. Examples include installation of home insulation and compact fluorescent light bulbs. The same level of home comfort or lighting levels are obtained using less energy. It applies technology, along with changes in behavior, to reduce electricity requirements.

The degree to which the PUD can rely on conservation programs depends on how customers use energy currently, the availability and cost of energy efficient technologies and practices, and customers' willingness to adopt them. The PUD recently conducted a comprehensive assessment of efficiency potential in Snohomish County and Camano Island. The study considered available technologies, distribution system efficiencies, and early stage energy-efficiency technologies that are likely to become available in the marketplace over the next 20 years.

The study included estimates of technical, economic and achievable potential for the range of scenarios outlined in Section 2. Based on these findings, staff conducted an analysis of programmatic gaps and opportunities and from this developed a conservation plan for each planning scenario.

As discussed in Section 5, conservation potential is measured at a technical, economic and achievable level. Future program goals and targets are established based on the assessment of achievable potential. The table below shows study results for the Base Case—96 aMW of conservation is estimated to be achievable between now and 2020, meeting 46% of the PUD's forecasted load growth.

Table 6-1

Energy-Efficiency Potential – Base Case 2020 (aMW)

Sector	2020 Baseline Sales	Load Growth- w/o Conservation (2008 - 2020)	Technical Potential	Economic Potential	Achievable Potential	Achievable Potential as % of 2020 Baseline Sales	Achievable Potential as % of Load Growth
Residential	505	119	87	62	48	10%	40%
Commercial	351	81	73	51	41	12%	51%
Industrial	110	8	8	8	7	6%	88%
Total	**966**	**208**	**168**	**122**	**96**	**10%**	**46%**

Close to 2,000 measures and combination of measures were considered in assessing conservation potential. In the residential sector, the study analyzed 69 unique measures for eight end-uses across three housing types and three vintages of homes. For commercial customers, 85 measures for 10 end-uses across 11 building types and two vintages were assessed. And for the industrial sector, the study considered 12 measures addressing 10 end-uses across seven industries. Tables 6-2, 6-3 and 6-4 below summarize the segments and end-uses evaluated.

Table 6-2

Residential Segments and End-Uses Evaluated

Residential Housing Types	End Uses
• Manufactured • Multi-Family • Single-Family	• Lighting • Central Heat • Appliances • Room Heat • Water Heat • Plug Load • Heat Pump • Room AC

Table 6-3

Commercial Segments and End-Uses Evaluated

Building Types	End Uses
• School • Grocery Store • Health • Large Office • Large Retail • Lodging • Other • Restaurant • Small Office • Small Retail • Warehouse	• Cooking • Cooling – Chillers • Cooling – DX • Heat Pump • HVAC Auxiliary • Lighting • Plug Load • Refrigeration • Space Heat • Water Heat

Table 6-4

Industrial Segments and End-Uses Evaluated

Industry Types	End Uses
• Machining/Equipment Production • Paper • Water/Wastewater • Food Processing • Chemical Manufacturing • Metal Manufacturing • Other	• HVAC • Air Compressors • Pumps • Motors • Lighting • Process Heat • Process Cooling • Fans • Other Process • Miscellaneous

In addition, 20 unique emerging technologies were considered, of which 14 were found to be economic. These include: green roofs, LED interior lighting, active window insulation, ultra-efficient fan motors for refrigeration, non-sweat refrigerator doors, and “one kWh/day” refrigerators.

Table 6-5 shows the economic and achievable potential under the Base Case using avoided costs that include the value of Renewable Energy Credits. This higher set of avoided costs was used to establish stretch goals for conservation.

Table 6-5

Energy-Efficiency Potential – Base Case 2020 (aMW)
Assuming “Green” Avoided Costs

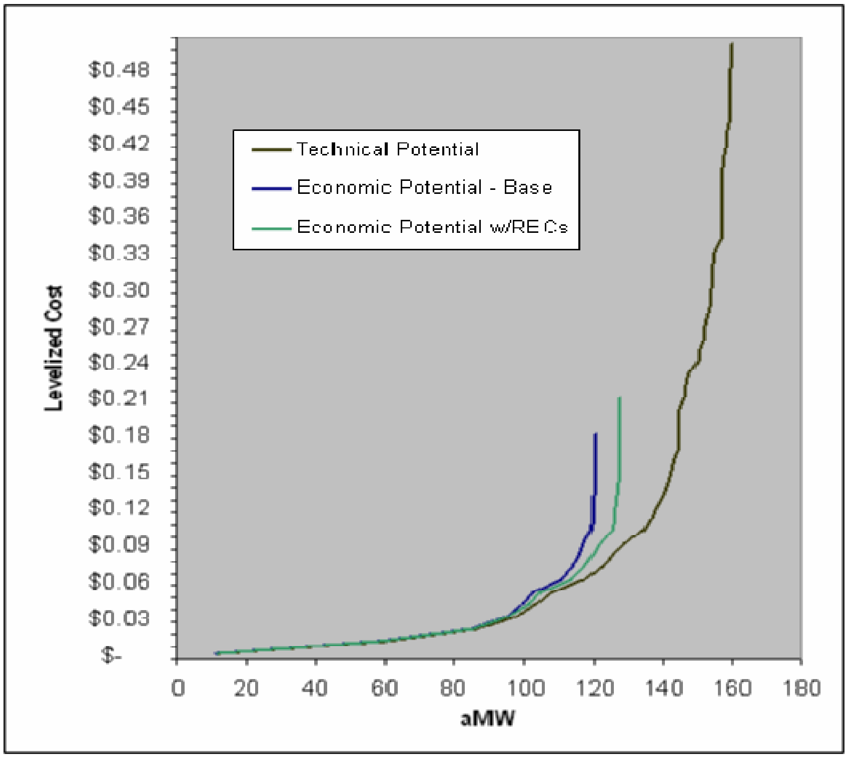
Sector	Economic Potential	Achievable Potential
Residential	66	51
Commercial	54	43
Industrial	8	7
Total	**128**	**101**

Figure 6-1 shows cumulative “conservation supply curves” for the Base Case under both sets of avoided cost assumptions. The curves show the relationship between the levelized, per unit cost of a measure (vertical axis), and its marginal contribution to total energy savings (horizontal axis). The conservation supply curve illustrates several points:

- Much of the identified technical potential is cost-effective—72% using the base case avoided costs and 76% with the addition of Renewable Energy Credits;
- Measures with levelized costs up to 16¢/kWh and up to 21¢/kWh (with green avoided costs) are economical based on their coincidence with peak; and
- The cost of achieving technical potential increases rapidly after about 150 aMW.

Figure 6-1

Energy-Efficiency Supply Curve



Discretionary vs Lost-Opportunity Resources

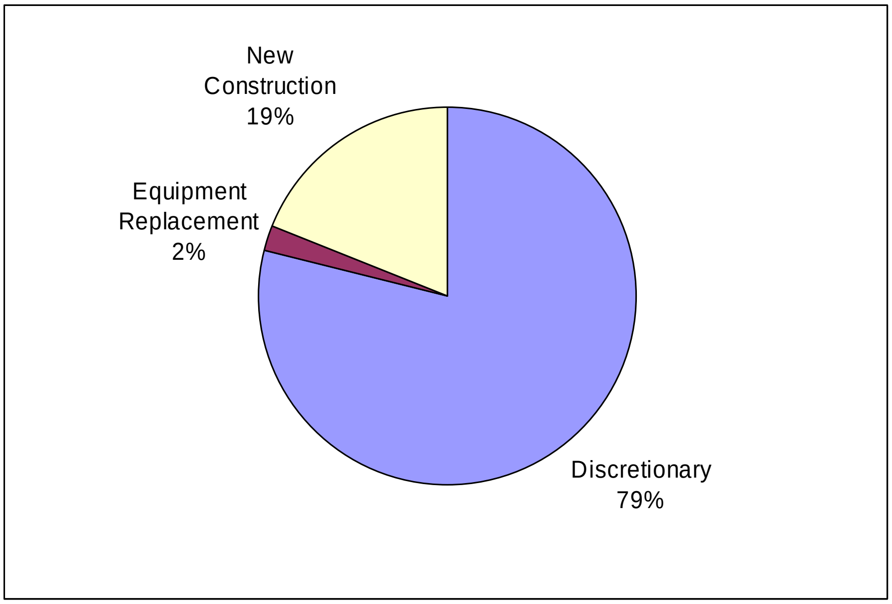
There are two types of efficiency resources: discretionary and lost-opportunity. The first involves measures that can be carried out anytime; the second describes measures that can only be captured during new building construction, remodeling, or when a piece of equipment is naturally replaced (when an appliance breaks down, for example). If efficiency resources are not installed at these points in time, the opportunity may be lost, or if not lost entirely, difficult to implement cost-effectively.

Of the total economic conservation identified in the PUD's service area, 79% was found to be discretionary (Figure 6-2). Twenty-one percent fell into the lost opportunity category, with the majority of measures involving new construction activities as opposed to equipment replacement. For the residential and commercial sectors, lost opportunities resources represent 25% and 20%, respectively, of potential measures. All of the economic and achievable potential in the industrial sector is considered discretionary.

Figure 6-2

Discretionary vs. Lost-Opportunity Resources
Percentage Breakdown

2008 -2020



Conservation Program Opportunities

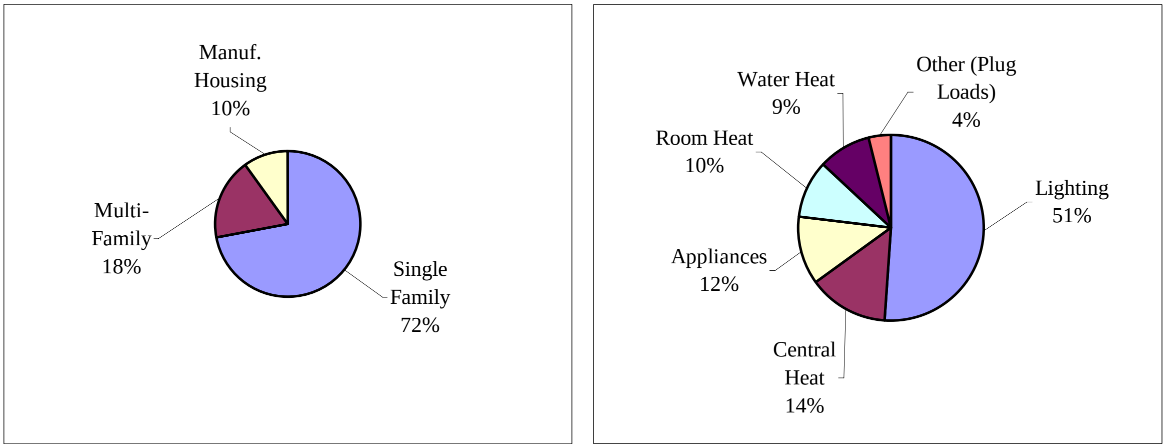
The conservation potential assessment identified several opportunities for expanding existing programs or offering new programs to customers. Conservation potential by sector, segment and end-use was compared to historical program achievements to identify gaps in the PUD's program portfolio.

Residential Program Opportunities

In the residential sector, efficiency potential is spread across three primary housing types: single family, multi-family and manufactured housing. Figure 6-3 illustrates the efficiency potential.

Figure 6-3

Residential Sector Efficiency Potential



Historical program achievements in the residential sector mirror the identified potential by end-use, but new opportunities do exist. Over the past several years, impacts in the residential sector have come from lighting, shell measures, energy efficient heat pumps, water heating, and appliances. Water heating savings come from high-efficiency clothes washers and dishwashers. Appliance savings come from the decommissioning and recycling of second refrigerators and freezers.

Future program impacts will continue to be driven by energy efficient lighting options including compact fluorescent bulbs, fixtures and LED lighting. Existing efforts to encourage manufacturers and retailers to make advanced lighting options more readily available will be expanded.

Space heating and cooling savings will be achieved by encouraging shell improvements and installation of energy-efficient equipment. Insulation measures, currently promoted to customers via financing and rebate options, continue to represent cost-effective efficiency potential. Advanced air-to-air heat pumps, ductless heat pumps and air-to-air heat exchangers provide additional equipment savings. New measures such as whole house air sealing will complement existing building shell improvements.

In the area of water heating, the PUD will monitor commercialization of heat pump water heaters, a promising technology that has yet to achieve significant presence in the marketplace. Technology improvements have made traditional measures like low-flow showerheads and aerators more cost-effective than in the past.

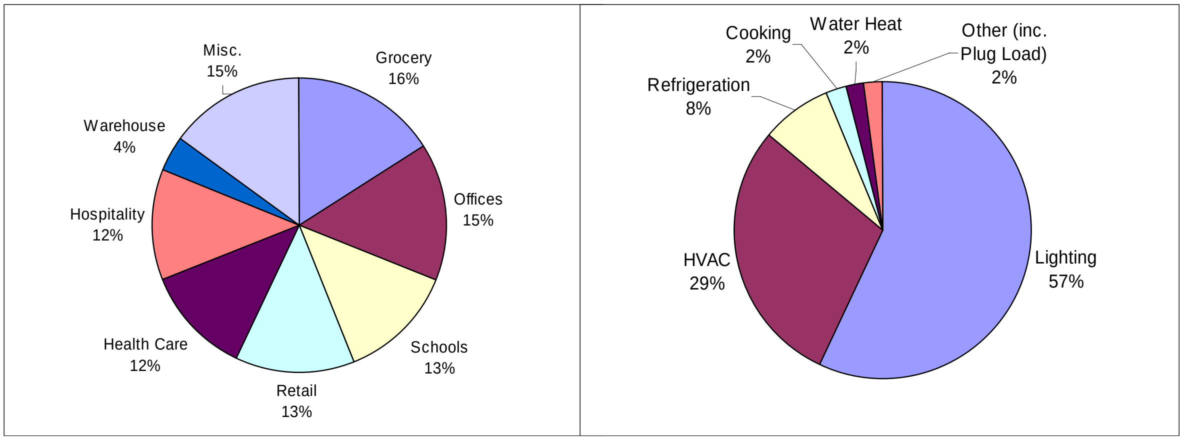
Current initiatives encouraging the adoption of energy-efficient appliances that exceed ENERGY STAR standards will be expanded. Adoption of efficient consumer electronics, those meeting or exceeding ENERGY STAR standards, will also be encouraged to address this rapidly growing use of energy in the residential sector. Customers will be incentivized through program standards and/or tiered rebates to choose the highest efficiency options possible. The PUD will increase its efforts to capture lost opportunities in the areas of new construction and equipment replacement. These efforts will be carried out in cooperation with other regional utilities, including natural gas providers. Educational materials will be designed to raise customer awareness of the impacts of energy consumption decisions, and to promote the availability of programs to assist customers.

Commercial Program Opportunities

In the commercial sector, the potential for greater energy efficiency is spread evenly across all business and building types. Lighting applications account for over half of the opportunities. As illustrated in Figure 6-4, significant potential also exists in heating, cooling and ventilation applications, and in refrigeration. Additional savings are available in the areas of cooking, water heat, and other uses, including plug loads.

Figure 6-4

Commercial Sector Efficiency Potential



In the commercial sector, program design is focused around delivery channels and market segments, rather than specific measures. With larger customers, the PUD develops custom projects that meet specific needs. Future efforts will seek to capture process-related efficiency opportunities, such as refrigeration in grocery stores, and ENERGY STAR cooking equipment in restaurants. The PUD will engage its trade allies to help market effective programs. The number of prescriptive rebate options will be increased to make it easier for customers to participate.

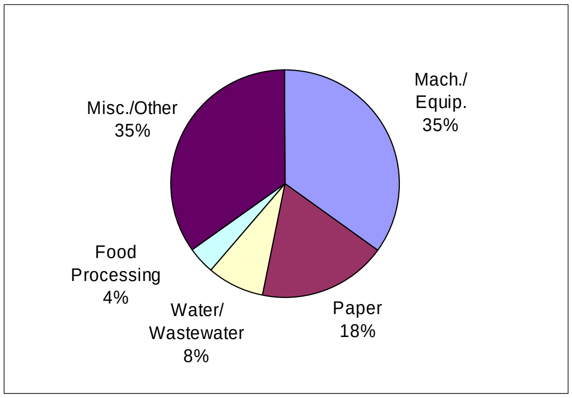
New lighting technologies that reduce lighting power density are now available and cost-effective for commercial construction applications. When combined with smart design and control, energy usage can be reduced significantly. While codes ensure the adoption of high-efficiency equipment and building envelope measures, assisting building owners and occupants with commissioning is critical to ensuring the expected savings are realized. The PUD will work with other regional utilities to provide this assistance to both customers and building professionals.

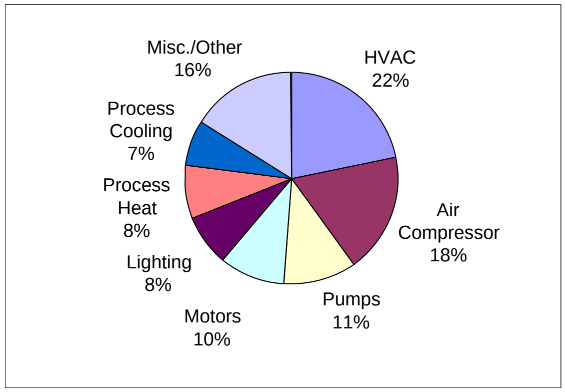
Industrial Program Opportunities

Figure 6-5 below illustrates the potential for greater energy efficiency in the industrial sector by industry type and end-use. The opportunities mirror the mix of industries operating in the PUD's service area.

Figure 6-5

Industrial Sector Efficiency Potential





Conservation and Account Management staff plans to continue to work with customers to identify specific opportunities and efficiency solutions across all end-uses—providing incentives and technical assistance as required to encourage customers to take action.

Cost-Effectiveness of Conservation Portfolios

Table 6-6 shows the projected benefit/cost ratios of the PUD's program portfolio by sector.

Table 6-6

Program Portfolio Cost-Effectiveness
Benefit-Cost Ratios

	Utility Cost Test		**Total Resource Cost**	
	Base Avoided Costs	**Green AvoidedCosts**	**Base Avoided Costs**	**Green Avoided Costs**
Residential	2.2	2.5	1.2	1.4
Commercial	2.9	3.3	1.3	1.5
Industrial	2.3	2.6	1.5	1.7
All Sectors	**2.5**	**2.8**	**1.3**	**1.4**

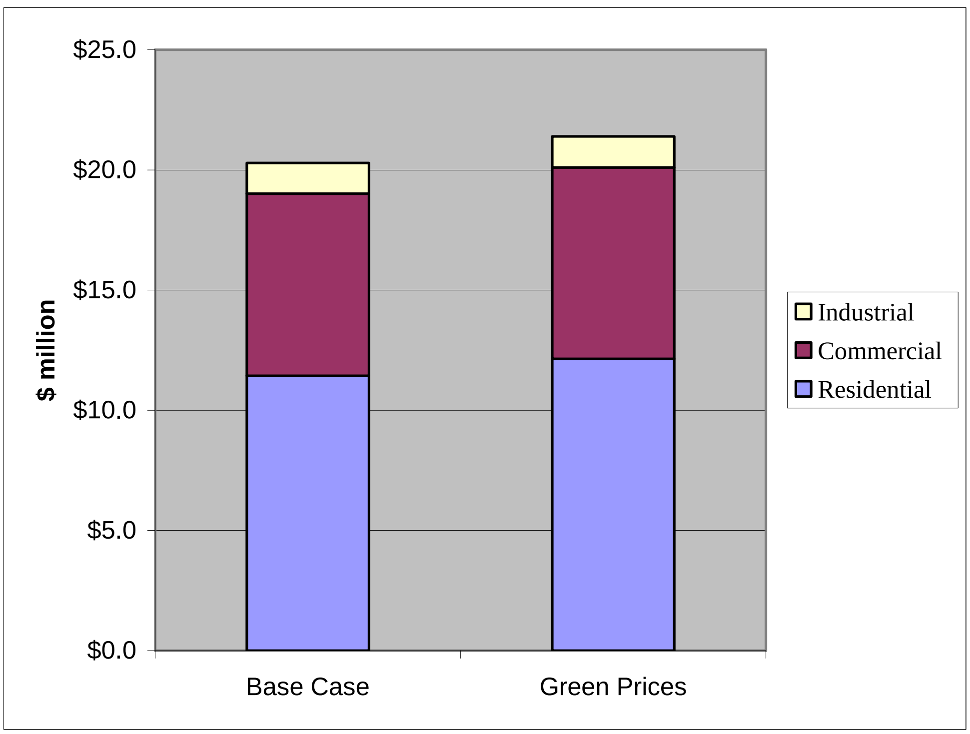
The utility cost test considers only the cost that the utility incurs in terms of incentives and program administration in calculating the cost of conservation. The avoided costs do not include the 10 percent Regional Act credit, allowed for conservation under the Regional Act.

In the total resource cost perspective, conservation costs include the total cost of a conservation measure plus any program administration or implementation costs. The avoided costs include a 10 percent credit for conservation as called for by the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Regional Act).

The projected annual budget for program design and deployment is based on the historic performance of PUD programs and anticipated need to increase resources (including marketing, technical assistance, and in some cases incentives) to meet more aggressive goals. Figure 6-6 shows the average annual sector-level expenditures anticipated to be needed to achieve the impacts assumed in the Base Case, with and without stretch goals. The total average annual budget from 2008 to 2020 is to be $20.3 million for the Base Case goals. This rises to $21.4 million if the stretch goals are added.

Figure 6-6

Average Annual Budget Requirements



The Potential for Demand Response Programs

Demand Response includes strategies that influence when and how customers use electricity. By shifting electricity demands from times when power prices are high to times of lesser cost, the PUD can lower its costs and, by extension, lower customers' bills.

Demand Response programs take four distinct forms: dispatchable load controls, scheduled load controls, voluntary calls to action, and price incentives. Dispatchable load control programs give utilities the ability to call on resources without any action from consumers. These resources are available immediately, often within 10 or 15 minutes after being dispatched by a utility. Scheduled load control programs require customers to temporarily change business processes and usually involves advance notice of requests for load reduction. From a utility's point of view, dispatchable and scheduled load control programs provide a high degree of resource certainty, once customers have enrolled in the program.

When energy shortages have been acute and short-term in nature, customers have responded positively to calls for voluntary energy reductions. This public appeal form of demand response is more effective the less often it is used. Price incentives rely on business economics to change consumption behavior. These programs trade lower prices for a customer's commitment to reduce energy consumption upon request.

Over the years, the PUD has implemented a variety of demand response pilots for both residential and commercial/industrial customers. Residential pilots have included a two-tiered pricing program and an electric space and water heating control project. In 2000, West Coast-wide power shortages led the PUD to participate in a regional demand exchange initiative. Although the program was never fully activated, the customers identified for participation at that time were called upon during a July 2006 power shortage. The voluntary call for action reduced demand by 10 MW over a six-hour period.

The PUD hired a consulting firm to develop a preliminary assessment of Demand Response potential in Snohomish County. Using a blend of engineering analysis and market data, the consultant found that winter peak demands could be reduced from by 15 to 64 MW, depending on penetration percentages assumed. The analysis focused on dispatchable load control using a variety of end-use technologies (process control, lighting, HVAC, etc.) and incentive options. Residential Demand Response measures were limited to electric space and water heating applications in owner-occupied homes. Residential potential was determined based on expected market response under different outreach and incentive strategies. The market potential for commercial and industrial customers assumed penetration rates between 0.5% and 3%. This compares to an industry rule of thumb that says over the long-term, and assuming a fully mature demand response program, a utility's peak load can be reduced between five and 10 percent.

Table 6-7 below shows the total megawatts potentially available from winter and summer load control projects at different market penetration levels.

Table 6-7

Demand Response Technical Potential

(MW of Peak Demand Reduction)

	10% of Residential Market and 0. 5% of C&I Market	**15% of Residential Market and 1 % of C&I Market**	**20% of Residential Market and 2 % of C&I Market**	**25% of Residential Market and 3 % of C&I Market**
Winter Impact	15.6	26.8	45.1	63.4
Summer Impact	8.9	16.8	31.8	46.8

The cost of Demand Response initiatives depends on infrastructure requirements, equipment and incentive choices, as well as the level of marketing needed to create a willingness on the part of customers to participate. Most programs to date have been implemented by utilities in warm climates with summer peak loads and have targeted air conditioning. Puget Sound Energy recently investigated direct load control of heater thermostats, but abandoned the pilot after learning that thermostat change-outs could only be performed by licensed electricians. The coordination and expense associated with hiring outside electricians made the program cost prohibitive.

Before pursuing potentially expensive direct load control projects, staff believes the PUD should first institutionalize voluntary load reduction programs, coupled with rate incentives. These programs leave it up to customers to determine which end-uses to curtail and rewards them, through rate discounts, for responding to voluntary calls for action or for simply standing ready to respond.

Based on the July 2006 customer response, staff believes there is at least 10 MW within Snohomish County that could be made available from customers to meet needle peak demands. Interruptible rates and standby generator programs are two possible mechanisms for capturing this resource and compensating customers for the value they can offer. Staff intends to investigate these and other options over the next year and to bring forth a program for the PUD Commission's consideration.

BPA Power Supply Options

Regional utilities are currently negotiating 20-year contracts with BPA for power deliveries from FY 2012 to 2028. BPA's Regional Dialogue process introduces a Tiered Rates Methodology (TRM), which will establish a new way BPA will set rates. BPA has proposed a rate design that differentiates costs between those associated with operating the existing federal system and those corresponding to new power supplies added to serve customer load growth beyond that which the existing system can handle.

Each preference utility will receive a High Water Mark that defines the amount it has a right to purchase at the lowest cost-based Tier 1 rate. Any power purchased above the utility's High Water Mark will be charged at rates reflecting BPA's marginal cost of acquiring energy. These added resources constitute the Tier 2 products. A utility may hold only one Priority Firm Requirements Service contract at a time as delineated in the following product offerings:

- Load Following
- Tier 1/Block

- Block/Slice
- Tier 2 Options

BPA Load Following Product

This product supplies BPA's customers with the amount of firm power needed to meet total retail loads minus the utility's own dedicated non-federal resource generation. The product is designed to follow a utility's load shape. It is not available to customers that operate as a balancing authority (control area). The rate for Load Following is proposed to include a composite and a non-Slice customer charge, a load-shaping charge, a demand and a load-following charge. A Load Following customer may elect to have BPA serve its above-High Water Mark needs, but a Tier 2 energy rate would then apply.

BPA Block Product

The Block Product provides firm power each month on a planned basis to meet a utility's annual net requirement load. BPA customers may choose between a Flat Block, where equal amounts of power are delivered over all hours, or a Shaped Block where power is shaped to the customer's forecast monthly requirements. The monthly shape will reflect the shape of the utility's load as measured for High Water Mark purposes. Customers can also purchase a capacity shaping product that would enable the Flat Block to be adjusted ahead of time.

The Block Product is not a Load-Following product and provides for no hourly changes in planned power amounts. The BPA customer is responsible for meeting the remainder of its loads with its own resources or market purchases.

The applicable Priority Firm rate for the Block Product includes a Tier 1 composite customer charge, a Tier 1 non-Slice customer charge, and a Tier 1 load shaping charge. If the Shaping Capacity Product is added to the Block, then a demand charge will also be added to the list of charges.

BPA Block/Slice Product

The Slice/Block Product is similar to the Slice/Block contract under which the PUD currently takes power. It combines two distinct power services for serving a customer's planned net requirement: Block service and Slice service.

The Block service under the Slice/Block product will be provided as either a Flat Block or a Shaped Block. Under the Shaped Block product, power deliveries are flat for all hours of the month. No variance is allowed between on-peak and off-peak periods. The capacity shaping product would not be available.

The Slice component provides power in the shape of BPA's generation from the federal system resources over the year. The Slice power purchase amount is based on a calculated percentage, equal to a portion of the utility's planned net requirement load, divided into the planned firm power from the federal system resources. This percentage is then applied to the actual power from federal system resources. A BPA customer's Slice percentage is calculated such that on a planned annual basis, the Slice power does not exceed the utility's net requirement when combined with the Block power.

The amount of firm power available to a customer under the Slice portion, like today, is dependent on federal system operations, snowpack and water conditions, and BPA power obligations. The Slice component also includes an advanced sale of surplus power in certain periods, which can vary with hydro conditions, BPA's obligations, and various power and non-power operating constraints (fish operations). Because the amount of firm power available under the Slice portion can vary, BPA customers who elect to purchase the Slice/Block product are obligated to provide their own non-federal power on all hours in which their total consumer load is in excess of the combined amount of Slice and Block.

The applicable Priority Firm rate for the Slice/Block Product includes a Tier 1 composite customer charge, a Tier 1 non-Slice customer charge (for the Block portion), a Tier 1 Slice customer charge (for the Slice portion), and a Tier 1 load shaping charge.

Like the other Tier 1 products, the Block/Slice offering will be limited to a utility's annual net requirements as calculated by BPA. In the past, BPA has decremented the PUD's entitlement to reflect the PUD's previous ownership interest in the Centralia power plant. BPA staff has given the PUD verbal assurance that for the next contract it will no longer do so. As a result, staff has assumed for planning purposes an additional 50 aMW will be available from BPA at Tier 1 rates, over and above the current contract amount of 706 aMW.

BPA Tier 2 Product Options

While BPA is still in the process of determining its final Tier 2 product line, it currently plans to offer a Load Growth Rate, a Short-Term Rate and a Vintage Rate.

The Tier 2 Load Growth rate is only available to BPA customers that purchase the Tier 1 Load Following product. Through this option, utilities can choose to have BPA provide for and manage all of their future power supply needs. BPA customers must make this election by November 1, 2009. While it is unclear if renewable resources will be part of this power supply, Renewable Energy Credits will not be passed on to BPA customers. To the extent BPA receives revenue from the sale of Renewable Energy Credits, that revenue will be used to reduce the price of the product.

The Tier 2 Short-Term rate will apply to utilities that need short-term access to additional power above their High Water Mark allocations. The product is available to all BPA preference customers, regardless of their Tier 1 election or whether or not they operate a control area. BPA will require five year commitments and a three year notice of intent to purchase. The initial term, however, will be only three years (2012 to 2014) with the election made by November 1, 2009. A customer must purchase this product to be eligible to purchase future Vintage Tier 2 products (described below). If a utility does not choose a Tier 2 product, but finds itself in a position where it must rely on BPA to serve loads above its Tier 1 allocation, the Short-Term rate will apply by default. Renewable Energy Credits will not be included as a part of the product.

Vintage Rates—specific to a particular generating plant—will be offered by BPA periodically. This product will be available to utilities that desire energy from certain renewable technologies or who want to tie future power supply costs to known resources. In order to participate, a utility must have already committed to BPA's Short-Term product. Because the resource is specific to a particular generator, Renewable Energy Credits will be passed along with the energy. Although no notice provisions have yet been established, BPA has indicated that the timing of commitment will be an important element of the product design.

Renewable Generating Options

Renewable energy resources will be a significant part of the PUD's future. This section outlines the different types of renewable resources available to the PUD, along with the advantages and disadvantages of each technology.

Wind Generation

Wind generation has rapidly become the renewable resource of choice in the Northwest and elsewhere. The technology has matured over the last decade, despite lingering issues surrounding gearboxes and bearing designs. Typical utility-scale wind turbines range from 1 to 2.5 MW with capacity factors of 25 to 35 percent of nameplate capacity.

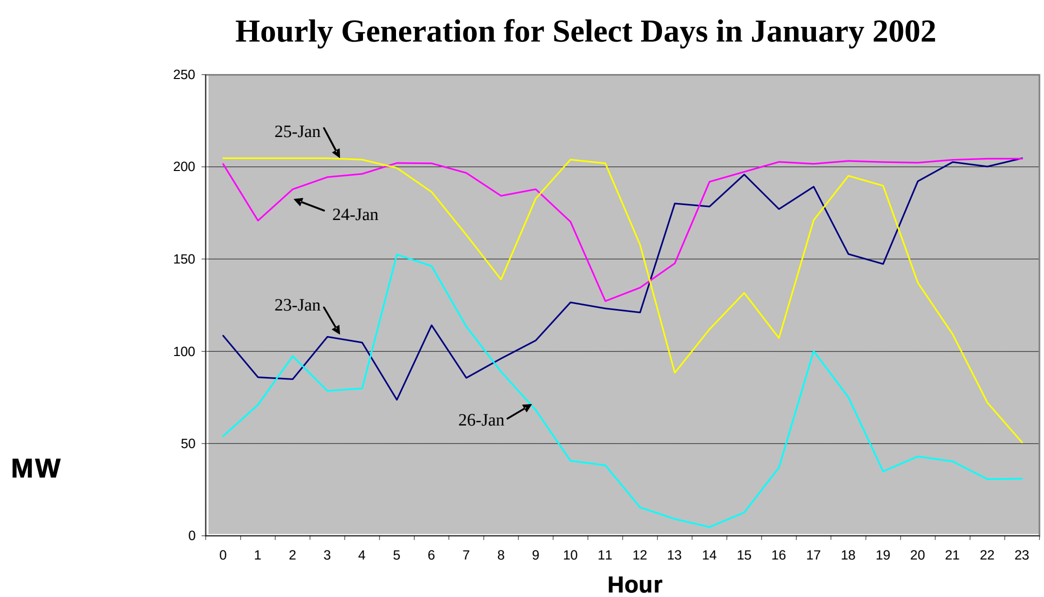
Over half a dozen public and private wind developers are active in the Northwest. White Creek and Nine Canyon projects are two examples of sites sponsored by public utilities. White Creek is a complex partnership between private developers, two PUDs and two cooperatives. Nine Canyon was developed by a group of 10 PUDs led by Energy Northwest. Private development companies in the field include Iberdrola, Horizon Wind, Summit Energy, BP Energy, and Invenergy.

The cost of wind has been rising due to turbine shortages, escalating steel prices, dollar devaluation, and increased demand. Capital costs currently range from $1,600 to $2,000 per kW depending on the site and project size (there are significant economies of scale with wind generation). Estimated operating costs range from $9 to $14/MWh; however, there is still considerable uncertainty over how these costs may fare over time.

The minute-to-minute, hourly and seasonal output of wind projects is highly dependent on location. Some sites are driven by winter storms and others by unique microclimates. Many of the sites with the best wind regimes are far from load centers and away from readily available transmission.

This intermittent nature of wind generation makes its output difficult to predict from hour to hour. To be able to make this generation useful for load service, another generating resource must be available and able to move rapidly in the opposite direction to serve load. Illustrated in Figure 6-7 below is the estimated output from a wind farm in Washington state. The chart is based on actual wind measurements for several days in January 2002 and each continuous line represents the expected generation for an individual day. As can be seen, wind generation for this particular site varies significantly between days and hours. Two adjacent days may bear no resemblance in terms of hourly generation patterns. This same observation holds true throughout the year.

Figure 6-7



Because of the large number of projects being proposed and built in the Northwest, the ability of existing regional resources to absorb wind variations has become a major planning issue. BPA's recent Wind Integration Study found that 6,000 MW of wind capacity could be integrated into the system, but only if certain proactive investments are made. The region will need to devote more time, effort and finances towards increasing transmission capacity, plant operator participation, and investment in flexible power technologies. Without that deliberate action, it will be difficult to fully utilize the Northwest's wind potential.

A firming or re-shaping product is often used to manage the variable output of a wind resource. The wind output is paired (firmed) by a more predictable generation resource like hydro, enabling the energy to be delivered (re-shaped) into a time of day or period when a utility can more fully utilize the energy to serve its customers. A firming service dampens the hour-to-hour fluctuations of a wind resource into a constant hourly output, while the re-shaping service absorbs the real-time fluctuations of the wind resource's production, and returns an equivalent amount of energy at a later time in a predefined shape (i.e., on-peak instead of off-peak, or in equal hourly amounts across a certain time period). Overall, firming and shaping services make the output of the wind project much more predictable and useful to the off-taker, and are typically paid for by the purchaser.

In past years, BPA had offered a firming and re-shaping product for purchasers of wind projects interconnected to BPA's transmission system. This product was designed to absorb wind energy, as it is produced, directly into the BPA hydro system, and then return the same quantity of energy some days later in equal quantity amounts during all hours of the day. The PUD secured a product of this type from BPA in conjunction with its White Creek Wind power purchase agreement, which commenced delivery for the PUD on January 1, 2008. BPA takes in the wind generation, firms it with hydropower and then returns the same amount of energy to the PUD seven days later in a pre-defined shape.

BPA has said it would no longer offer this same product for other wind projects. BPA staff tells the PUD the agency needs to evaluate the extent to which the federal power system has the capacity to provide these services. Recent court decisions have reduced the flexibility of the hydro system. And concerns over carbon footprints may limit the use of natural gas generation for firming.

In March 2008, BPA completed its first Wind Integration Rate Case for 2009, with the region's stakeholders agreeing to a one-year settlement of issues. The primary concern was the rate BPA will charge for integrating wind resources into the existing transmission system. As part of the settlement, BPA agreed to establish a cross-agency team responsible for studying a variety of wind integration issues; it will conduct public workshops to determine the necessary within-hour regulation reserves required to integrate wind; and it will develop a cost allocation method. Wind generators will be required to provide production data to BPA to aid in the studies. During 2009, wind generators will pay BPA an interconnection rate of $0.68 per kilowatt-month, which equates to roughly $3.18/MWh. The parties agreed that the one-year settlement would not set a precedent for future BPA Wind Integration Rate Cases with regard to the interconnection rate or the cost allocation methodology.

Geothermal Power

Geothermal power uses steam from hot fluids in underground rock formations to run turbine generators. Viable geothermal reservoirs are those that have adequate heat, rock permeability, and water and site accessibility. Geothermal power plants typically produce power by either flashing hot water into steam or using the hot water to heat a second working fluid (such as isobutene, which vaporizes at lower temperatures than water). After the water steam or vapor is passed through a turbine, it is condensed and returned back into the reservoir. To prevent resource degradation, geothermal reservoirs must be managed by re-injecting water back into the reservoir. The Geysers geothermal plant in California, for example, re-injects treated municipal wastewater as part of its reservoir management program.

Geothermal power technology has been in use for over 40 years in the U.S., but its application has been limited by the number of commercially viable sites. Geothermal resources tend to be located in areas of volcanic activity, and as a result, potential development is often within or near national parks or wilderness areas. It is estimated that approximately 90% of the potential geothermal resources nationwide are on federal land.

Geothermal plants are capital intensive, in the range of $3,000-$7,000/kW, depending on the precise nature of the site and resource. This high cost is due partly to the cost of drilling exploration wells, which may or may not find a suitable reservoir. On the other hand, geothermal power production is a very well understood and mature technology. Given successful exploration and discovery of a geothermal reservoir with the necessary attributes (fluid temperature >300°F, depth <3,000ft, and adequate permeability), a geothermal resource has all of the advantages of a coal-fired plant at a low variable operating cost and without significant air pollution or other environmental impacts.

A 2003 DOE study identified the top three potential sites in Washington as Mt. Baker, Mt. Adams and Wind River areas. Because this assessment was based on limited exploration of the North Cascades, the PUD determined that it would be worthwhile to contract with a consulting firm. Black Mountain Technology (BMT), was hired to determine if there could be viable utility-scale geothermal power opportunities in Snohomish County.

BMT utilized several tools in its research—including geology, geophysics, tectonic stress information, seismic data, temperature data from wells and springs, and geochemistry. The company also looked at terrain accessibility, land use information and access to transmission. The study identified several favorable sites that warrant further exploration.

The study assessed the size of geothermal resource potential and the estimated development costs of several sites, taking into consideration both the hydrothermal geothermal (naturally occurring) and Engineered Geothermal Systems (EGS) resources. EGS is a new technology that enables development of projects that previously were not viable due to a lack of adequate permeability. EGS creates the required permeability by hydraulically fracturing rock to improve the circulation of fluids. EGS promises to open up a number of locations where potential geothermal resources could be explored and developed, and could bring the cost of the resource into line with other alternative energy resources.

The study resulted in the identification of several specific areas in and around Snohomish County which warrant additional exploration and assessment for both hydrothermal and EGS potential. If the earth's heat can be tapped at any of the areas identified, it could supply a considerable amount of baseload energy for the PUD.

Before the potential cost of developing a geothermal resource can be undertaken, additional temperature data must be gathered. Research drilling is utilized to explore temperatures and other relevant attributes at various depths. These exploratory wells can cost roughly two million dollars a hole. These costs are based on currently available technology, which tends to dominate the levelized cost of energy. Over the next five years, improved technology could make geothermal energy more competitive with other alternative energy resources. BMT estimates that as much as 1400 MW of combined EGS and hydrothermal power is available in and near Snohomish County at around $0.06 to $0.10/kWh using 5% bond financing. The PUD is currently working on development plans. The next phase is anticipated to include the identification of specific locations for exploratory well drilling, followed by the drilling and assessment of a small number of exploration wells.

Staff believes this exploration will be successful and enable geothermal power to become a major component of the PUD's resource portfolio. Staff also hope that the work it engages in with respect to EGS technology will advance the progress of geothermal energy and technical development throughout the U.S.

Low Temperature Geothermal

There are many portions of the U.S. where geothermal temperatures are not high enough for conventional geothermal technology. The nation's first low-temperature geothermal plant is located at the Chena Hot Springs Geothermal Resource in Alaska. These hot springs never reach the boiling point of water, so a secondary (binary) fluid called R-134a, which is a common refrigerant fluid with a lower boiling point than water, passes through a heat exchanger with 165-degree water from the hot spring wells. Heat from the water causes the R-134a to flash to vapor which drives the turbine.

In short, the system utilizes a refrigeration cycle in reverse to generate power, which is not a new concept. It takes advantage of the temperature differential (as little as 100 degrees) between the evaporation and condenser temperature. Since air-conditioning and refrigeration equipment are common, the price to adapt this technology for power production is not high. Several 350kW systems can be clustered to produce power at the cost of about $0.07/kWh.

Staff has been monitoring this small-scale technology and plans to include it as a potential option in its larger geothermal efforts.

Biomass

The term biomass applies broadly to resources that utilize animal waste, wood waste, woody plants or other such fuel sources. In general, projects tend to come about because of site-specific reasons and are quite small in scale. Biomass projects that apply an anaerobic digestion process to animal wastes are usually developed as a means to deal with waste pollution from dairy cows or other farm animals. The methane produced can be burned directly for heating or used to run a generator. Projects that produce electricity are usually under a megawatt in size.

Wood-waste-fired generation projects are often associated with wood-industries such as lumber mills and built as co-generation facilities (utilizing part of the heat from burning the wood waste to produce steam for process needs). Such plants generate electricity as a by-product and are dependent upon the economic cycles of the host industry. They are often single generator machines with no back up and are typically of a non-commercial size. This results in a significantly less dependable source of energy for purposes of reliably serving load and makes the power from the resource less valuable than other forms of generation.

In summer 2007, PUD staff conducted an extensive analysis of the potential for producing electricity from farm-based anaerobic digesters. The study indicates that the resource has limited potential in the county, in part because local dairies are generally smaller than the recommended minimum size for installing digesters. Anaerobic digesters offer dairies diverse, substantial benefits, but energy production alone does not justify the investment. The PUD has been contacted regarding two proposed projects for centralized, multiple dairy digesters totaling less than 2 MW of capacity. Also of interest are two local companies that manage waste streams in the county, which may offer the potential for as much as 10 MW of output.

Landfill Gas

A landfill gas-to-energy plant uses organic waste that decomposes to produces methane as a natural by-product. Methane however, is considered a potent greenhouse gas and is 20 times more destructive than carbon dioxide. In order to protect the environment, gas from landfills must be flared in order to protect air quality. Landfill gas energy production collects the methane in a network of wells and perforated pipe buried in the landfill itself. Blowers create a vacuum system to draw the methane out of the landfill before it is released into the air. Impurities are filtered out allowing clean, compressed gas to fuel modified reciprocating engines.

Landfill gas energy is considered a desirable baseload resource because it delivers energy in a very smooth flat shape. It is reliable, predictable and cost effective. The PUD’s current contract with Klickitat PUD for 5 aMW from the Klickitat landfill expires in 2009. Staff intends to renew the contract, assuming the new price and terms are acceptable. If and when KPUD expands its landfill gas generation, staff may be interested in negotiating another 5 aMW.

Ocean (Wave & Tidal)

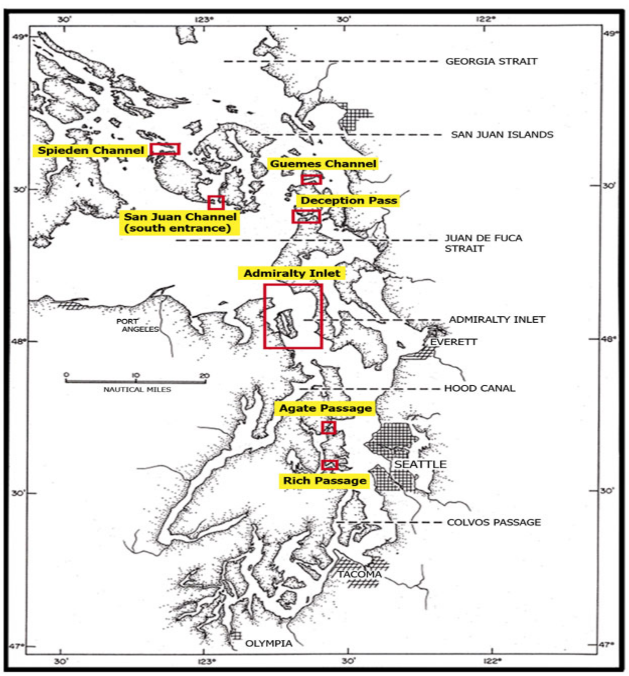
Efforts to harness the power of ocean waves and tides have increased dramatically in recent years. In the U.S., much of this interest has been driven by the exploratory work of the Electric Power Research Institute (EPRI), which recently authored numerous technical papers on ocean energy topics. Even so, efforts in the U.S. have lagged behind those in Europe.

While the potential energy production from ocean waves far exceeds that of tidal power, our proximity to the Puget Sound estuary makes tidal in-stream energy conversion (TISEC) a compelling opportunity. Unlike wind and solar, tidal power is predictable for months, years and even decades into the future. This predictability, coupled with the proximity of the Sound to large load centers (easing transmission issues), makes tidal power of particular interest. Though preliminary (given the current lack of any utility-scale TISEC generation anywhere in the world), the EPRI estimate indicates the capital cost of tidal power to be approximately $3,000/kW. There is, however, a host of regulatory, social, technical, and environmental challenges to overcome before tidal power in the Puget Sound can become a reality.

The PUD has taken a leading role in the research of tidal power in the Pacific Northwest. In March 2007, the utility received permits from FERC to study seven locations in and around the Puget Sound. The FERC permits allow the PUD to study the potential of tidal energy at these sites. Per the parameters of the permit, the entire study period can take up to three years. The studies will confirm whether the projects are technically and economically viable, and if they can be executed in an environmentally responsible manner. Figure 6-8 below shows the seven sites located from Rich Passage near Bremerton to Speiden Channel in the northern San Juan Islands. Based on preliminary studies, these seven sites combined could provide up to 100 aMW of electricity.

Figure 6-8

Potential PUD Tidal Sites



As part of its initial study phase, the PUD has been measuring the velocity and direction of tidal currents, considering potential tidal devices to employ, assessing environmental and regulatory issues, determining how best to connect the energy to the electrical grid, and conducting computer modeling studies to evaluate site conditions. Assistance has been received from BPA, Energy Northwest, the University of Washington, and EPRI.

Staff anticipates the study phase to last through 2009 and once complete, staff will evaluate the technical, economic, and environmental viability of pursuing a pilot demonstration plant. A target date for the pilot plant is 2011, with the earliest generation available in 2013, for up to 1 to 2 MW. For resource planning purposes, staff has assumed that up to 5 MW of tidal capacity could be installed by the year 2020.

Solar

Solar energy is characterized by two general types of systems: photovoltaic (PV) solar cells and solar thermal arrays. Solar energy generation from conventional PVcells is growing rapidly worldwide, and substantial research/engineering is being applied towards thin-film photovoltaic devices that have the potential to be much less costly to produce. Lenses with mirrored dishes that focus sunlight on solar cells, thermal troughs/dishes and Stirling cycle heat engines have also been developed. These approaches generally require automated tracking systems to be effective.

Solar energy is not as compelling in Washington as it is in sunnier locales, but in the coming years as PV manufacturing/installation costs decline and system efficiencies increase, solar energy could have a meaningful position in a well-diversified energy portfolio. Puget Sound Energy is currently developing a 500 kW solar PV array at its Wild Horse Wind Project east of the Cascades. At a cost of $8,000/kW, solar PV systems are currently prohibitively expensive for utility-scale power production.

Several federal and state incentives are making small-scale PV more attractive for commercial and residential applications. Federal tax incentives allow businesses to write-off up to a third of the cost of a PV system. Residential applications are offered the same incentive, but the amount is capped at $2,000.

A relatively new state program pays owners of residential and business PV systems 15 cents per kWh of solar energy produced until 2014. If the system utilizes panels and inverters manufactured in Washington state, the program will pay up to 54-cents per kWh. These and other incentives can result in payback periods of less than 10 years for commercial systems and 15–20 years for residential systems.

While solar is not as cost-effective as other forms of renewable energy, staff are seeking the best ways to bring solar opportunities to Snohomish County residential and small business customers. Even though staff have not included solar resources in the resource stack over this planning horizon, efforts are underway to create a program that supports customer-owned solar through rebates, loans and incentives, technical advice, and active communication.

Hydro Power

As the nation looks for more domestically supplied energy, small and low impact hydro is emerging as a promising alternative. The Energy Policy Act of 2005 directs the Secretary of Energy to pursue a vitalization effort for hydropower, much the same as the Department of Energy did for wind power. With aggressive measures in place, the equivalent wind-level commitment of $377 million over a 10-year period could yield 23,300 MW of waterpower capacity by 2025. EPRI estimates that 2,700 MW of new small and lower-power hydro plants (<30 MW) and 5,000 MW of new conventional hydropower plants at existing non-powered dams is possible in the U.S. by 2025. FERC has also been mandated to decrease the amount of time it takes to license a new or added-to project, which could reduce the licensing period from the previous five to 10 year range to a one or two year period.

Small hydro can include mini-hydro (<1 MW), micro-hydro (<100 kW) and pico-hydro (<1 kW). The amount of energy that can be captured is a function of the vertical distance the water drops (the head) and the volume of the water. One hundred cubic meters of water falling 10 meters (low-head application) represents the same energy potential as 10 cubic meters of water falling 100 meters (high-head application). Actual output depends on how efficiently the power of the water is converted to electricity—maximum efficiencies of over 90% are possible, yet 50% is more realistic. Another method of capturing the hydraulic energy is to divert the water out of the natural waterway through a penstock and then back to the waterway. Such run-of-river applications allow for hydroelectric generation without a dam. Small hydro projects generally do not have large storage reservoirs and are not dependable as dispatchable resources as they rely on seasonal water flows. However small hydro projects tend toward long life (25 to 50 years), simplified permitting and low O&M costs. Items to consider when planning a small-scale hydro project are the environmental impacts, water rights, planning and land-use laws, and access to transmission.

Some states count small hydro toward renewable compliance standards, but Washington state's I-937 rules does not make fresh water generation (other than incremental hydro) eligible, no matter the size. Even so, the PUD sees small hydro generation as an attractive option, because it is emissions-free. Several potential small sites within the PUD service territory have been identified. One that staff is actively considering could provide between 2 to 4 aMW of power. Nationally, there is a market for Low Impact Hydro Power (LIHP) Renewable Energy Credits, and certification of a PUD resource as Low Impact could provide additional revenue.

Jackson Hydro Project

Incremental hydropower from the Jackson Hydro Project can be added directly into the PUD's resource mix. Staff anticipates that by reconfiguring the penstock at the Jackson project, generation can be increased from its current 103 MW capacity to a 112 MW rating. This type of incremental hydro qualifies as a renewable energy resource under I-937, so it would count towards the PUD's compliance needs.

Packwood Hydro

The Packwood Lake Hydroelectric Project began operation in 1964 and is located in the Gifford Pinchot National Forest (approximately 20 miles south of Mount Rainier). Power plant structures at the lake are limited to a small diversion and intake pipe a short distance downstream from the outlet of Packwood Lake. A five-mile underground pipeline carries the water down the mountain to the powerhouse, which is near the town of Packwood. There is an 1,800-foot drop in elevation, which enables generation of up to 27.5 MW of electricity. PUD staff is currently involved in the contract management of Packwood hydro project. In the near future, the PUD may have the option to recall its 2 aMW share of generation from Franklin and Benton PUDs.

Pumped Hydro

Pumped hydro is considered an energy storage resource. It has been in use since 1929, and until 1970, it was the only commercially available storage option for large-scale generation applications. Conventional pumped hydro facilities consist of two water reservoirs: one located at a base level and the other at a higher elevation. Water is pumped to the upper reservoir during off-peak hours where it can be stored as potential energy, and upon demand, the water is released back into the lower reservoir, passing through hydraulic turbine generators.

The barriers to pumped hydro storage can include high construction costs, long lead times and geographic, geologic, environmental constraints associated with reservoir design. Access to supplemental external water refill is also a concern. Pumped-hydro storage facilities generally operate on a daily or weekly cycle. They are ideally suited to utility systems where a significant difference exists between on- and off-peak power prices.

The reasons for building pumped storage have changed over the past 30 years. In the 1960's projects were built to provide low-cost peaking capacity instead of steam turbine or combustion plants. Later, pumped hydro was recognized for its ability to provide on-peak energy, spinning reserves and its load-following capabilities. With the growth of wind farms, pumped hydro has added value as a possible avenue for shaping off-peak wind output into more valuable on-peak hours.

Along with energy management, pumped storage systems can help control electrical network frequency and provide reserve generation. Thermal plants are much less able to respond to sudden changes in electrical demand, potentially causing frequency and voltage instability. Pumped storage plants can respond to load changes within seconds.

In mid-2007, the PUD commissioned a study on the possibility of pumped storage within its service territory. The research indicates several viable sites within the county that could be utilized for pumped hydro. Two sites were considered potentially attractive options, with a range of generation from 100 MW to 125 MW. Pumped hydro could offer value to the PUD as a capacity resource. Some additional benefits include:

- Reshaping low-cost off-peak energy from wind and other resources to meet on-peak loads;
- Providing regulation support during on-peak hours;
- Providing operating reserves and other ancillary services, which the PUD now purchases; and
- Reducing the need for additional transmission.

The value of pumped hydro for integrating wind on an hourly basis is not clear at this time. The PUD will continue to explore the benefits and costs of using pumped hydro as a viable peaking and reliability resource.

Emerging Technologies

There are many technologies that are emerging or that have not been fully developed due to high costs and lengthy research processes. Fuel cells, hydrogen, fusion, wireless electricity, plasma gasification, biofuels, organic photovoltaics, and various forms of nanotechnology may all play a role in filling future energy needs. The staff at the PUD will continue to monitor innovations that are on the horizon. Appendix E provides a high-level overview of some future technologies.

2007 Request for Proposals for Renewable Resources

In July 2007, the PUD issued a Request for Proposal (RFP) seeking up to 100 aMW of renewable energy between 2008 and 2012. The RFP did not seek specific renewable technologies. However, the PUD stated a preference for renewable projects of 5 MW or larger that qualify for I-937 compliance, such as wind, tidal, solar, biomass, landfill gas, and geothermal. The objective of the RFP was to obtain the most economic and reliable renewable resources for the PUD's supply portfolio. In evaluating the proposals, the PUD was interested in the renewable resources that best aligned with several criteria: compatibility with resource needs, cost, risk management, public benefits, and strategic and financial goals.

The PUD received 10 proposals including eight wind, one hydro and one biomass proposal for a total of 360 aMW. Based on the criteria outlined in the RFP, staff short-listed five projects in November 2007, and then requested additional information and set up clarifying interviews with the sponsors. In December 2007, four projects were selected to a final list. This list included three wind and one hydro project for a total of 75 aMW. Contract negotiations with the proposers are currently taking place.

Fossil-Fuel and Nuclear Generation

Fossil fuel options include predominantly two subsets: natural gas-fired and coal-fired generation. Each technology has advantages and disadvantages. Issues associated with natural gas and coal-fired generation include environmental concerns, fuel cost volatility, fuel availability, changing regulations, and taxes associated with carbon dioxide emissions and other global warming precursors. Nuclear power production has recently enjoyed renewed interest because of its lack of green house gas emissions. However, because there are no plants contemplated in the Northwest, additional nuclear power does not represent a near-term option for the PUD.

Gas-Fired Generation Types

- *Simple Cycle Turbines* – This technology is essentially a jet engine turning a generator. It is typically used for peak load service during high price market conditions and for meeting load variations from intermittent resources.
- *Combined Cycle Turbines* – Combined cycle turbines add a boiler to the simple cycle technology. The jet engine turns a generator and the waste heat from the process is used to generate steam for a turbine/generator set. This generation type has been the technology of choice for meeting base and intermediate loads due to

its relatively low capital cost, quick construction lead-time and high fuel efficiency.

- *Natural gas-fired boilers* – In this technology, natural gas is used as a boiler fuel to make steam for use by a steam/generator set. These plants were commonly used for base-load applications until the advent of the newer and higher-efficiency combined cycle turbine technology became available.
- *Co-generation* – Also referred to as "combined heat and power" plants, co-generation facilities can consist of several technology configurations. One design involves a combined cycle plant where the boiler also provides steam to a host industry or commercial enterprise such as a hospital. Other technologies include use of natural gas or a waste fuel, such as wood chips, in a boiler to provide both steam and power. When appropriately sized for the host thermal load, such an arrangement can result in thermal efficiencies in the neighborhood of 80 percent. Even so, it is often difficult to design and allocate capital and operating costs in ways that make these projects cost-effective.

Coal-Fired Generation Types

- *Pulverized Coal* – In a pulverized coal plant, coal is ground up and injected through nozzles into a boiler where it is burned to raise steam, typically at high temperature and pressure, which is in turn used to drive a turbine and generator.
- *Fluidized Bed* – In a fluidized bed coal plant, pressurized air is injected under a grate in the bottom of the coal-fired boiler. Crushed coal particles float inside the boiler, suspended on upward-blowing jets of air and are "fluidized." Limestone is mixed with this fluidized coal. The result is a more thorough burn of the coal, especially for lower quality coal, and removal of 90% plus of the sulfur and nitrogen pollutants. Typically, the boiler is also able to burn other fuels such as wood or waste tires.
- *Integrated Coal Gasification* – In this technology, coal is gasified by baking it in a large container in the presence of oxygen. The result is a synthetic gas similar to natural gas, which can then be used in a gas turbine combined cycle plant (with special technology) to generate electricity at high efficiency. There are several

advantages to this technology. First, the cost of electricity produced is not subject to the cost, volatility, and supply issues associated with natural gas; second, harmful emissions are much lower than conventional coal plants; and third, with some technology improvements it may be possible to sequester the CO_2 emissions, a primary contributor to global warming.

Carbon sequestration refers to the provision of long-term storage of carbon dioxide emissions in the terrestrial biosphere, underground or oceans. In some cases, this is accomplished by maintaining or enhancing natural processes; in other cases, novel techniques are being developed to dispose of carbon. To be successful, the techniques must be effective and cost-competitive; provide stable, long-term storage; and be environmentally benign. Using present technology, the U.S. DOE estimates sequestration costs are in the range of $100 to $300/ton of carbon emissions avoided.

Nuclear Energy

Nuclear energy is produced by a controlled nuclear chain reaction. When a neutron strikes a relatively large fissile atomic nucleus, it forms two or more smaller nuclei as fission products, releasing energy and neutrons in a process called nuclear fission. The neutrons then trigger further fission, and so on. Whereas a conventional thermal power plant relies on a fuel source such as gas, coal or oil to provide heat for generating electricity, a nuclear power plant uses nuclear fission inside the nuclear reactor to create heat. The heat is then used to boil water, produce steam and drive a steam turbine.

Nuclear power provides roughly 17% of the world's electricity with 435 operating reactors spread among 31 different countries. The U.S. has 103 reactors and, although it has the most nuclear capacity of any nation, no new commercial reactors have come on line since May 1996. Nevertheless, U.S. commercial nuclear capacity has increased in recent years through a combination of license extensions and upgrading of existing reactors. New nuclear plants are now being considered by utilities in the southeastern U.S., where coal has previously dominated.

Difficulties with nuclear planning include long lead times regarding licensing, siting, rate recovery and financing uncertainties. Capital costs are high, ranging from MIT's 2003 estimate of $2,000-$2500/kW to Florida Power & Light's 2007 range of $5,200 to $7,800/kW. The wide range of capital cost estimates stems from a lack of consistent economic methodology -- with some entities estimating project costs on an overnight basis, while others utilize current or discounted dollars. Life cycle cost estimates range from $0.05 to $0.17/kWh.[1] A shortage of uranium and trained nuclear technicians is also cited as an issue for nuclear development.

Some people are opposed to nuclear power based on concerns over long-term storage of radioactive waste and the potential for accidents at power plants. National security issues related to plant sabotage and nuclear proliferation have also been raised. Proponents claim that risks are small and can be overcome. They point to nuclear's baseload energy production and zero carbon emissions as attractive features. There are a number of advanced nuclear reactor designs under development that could make critical fission reactors much cleaner, safer and less risky with regard to proliferation of nuclear weapons. A recent poll by KCTS television found that 56% of those surveyed in the Seattle area now view nuclear energy in a positive light.

That said, the likelihood of a new nuclear plant being built in this region is small. According to Vic Parrish, CEO of Energy Northwest, the US has the manufacturing capacity to build only 11 nuclear plants at any time. With 32 orders in the U.S. queue currently, and a construction time of five years, the Northwest could not count on a nuclear resource before the year 2030.

[1] Harding, Jim. "Reactor Economics 2008." Presentation at the National Academy of Sciences/National Research Council Panel Jan 22, 2008 in Washington, D.C.

Wholesale Power Market

Physical Energy

In order to meet the daily, hourly and within-hour power needs of the PUD, staff actively purchases and sells power in the wholesale energy market. Contracts for short-term energy are made up to 18-months in advance. On a daily basis, contracts are often negotiated and transacted within minutes.

Financial Instruments

Financial instruments work like insurance products. They are premiums paid to ensure a certain price or a certain amount of energy will be available when and if needed. The instruments help the PUD optimize its economics and power costs.

Call options are a financial instrument used by the PUD to lessen the risk of buying large amounts of unnecessary energy on the wholesale market to cover a small percentage of peaking load days. Similar to a physical purchase, the call options allow staff to exercise the purchase of physical energy at a fixed price to meet uncertain peak loads. These options are purchased from trading parties who are market makers in the Pacific Northwest energy-trading hub.

Financial hedging is another instrument that will be used by the PUD in the future to enable it to cover its price exposure in illiquid physical markets.

Transmission Resources

The PUD has actively participated and supported BPA’s Network Open Season initiative, which addresses the region’s need for new transmission investment and transmission queue management. BPA will evaluate all transmission customer requests for transmission services in parallel, rather than sequentially as in the current process. Customer contract commitments will give BPA certainty that customers will exist for future services. Improved data will allow BPA to efficiently plan and expand the transmission system.

Table 6-8 lists the service requests the PUD submitted to BPA as part of the Network Open Season process. The amount and timing of these requests reflects the PUD's forecasted load growth in the Base Case, with an allowance to meet extreme winter peak loads.

Table 6-8

Network Open Season 2008 Transmission Requests

Year	MW	Point of Receipt	Point of Delivery
2011	50	BPA System	NW Hub
2011	50	BPA System	PUD
2013	50	BPA System	PUD
2015	50	Rock Creek Substation	PUD
2017	25	Midway	PUD
2017	25	NW Hub	PUD
2018	25	NW Hub	PUD
2018	50	BPA to NW Montana	PUD
2018	25	Midway	PUD

Regional Transmission Projects

In December 2003, the 500kV Kangley-Echo Lake transmission line was energized. Only nine miles long, it became the first new 500 kV line built in the Puget Sound in decades. A number of large transmission projects have recently been proposed and reinforcements are being considered to integrate new resources and reduce congestion.

- BPA's Proposed I-5 Corridor Reinforcement project will reinforce the South-of-Allston path, which has been a limiting path in the summer. The I-5 project will increase system capacity, provide firm transmission service for proposed generation projects and increase system reliability. Currently this I-5 project is in phase-one of the WECC rating process.

- BPA's West-of-McNary project will reinforce the West-of-McNary, West-of-John Day, and West-of-Slatt cut planes (interfaces). This reinforcement is needed to provide additional transmission capability for new point-to-point transmission requests across multiple congested east-west transmission paths along the Washington-Oregon border.

- The California Oregon Intertie (COI) upgrade project will not increase the total transfer capability of the COI, but is expected to increase the average operating transfer capability by reinforcing the reactive capability of the path. Based on initial studies, the COI upgrade will provide significant benefits to the Pacific DC Intertie and the Midpoint Summer-Lake line capability. BPA, PacifiCorp and Portland General Electric are the Northwest owners sponsoring the project. Funding is on a pro-rata basis among all eight capacity owners.

In addition to these regional transmission upgrades, three proposed projects would add new connections between the U.S. and Canada:

- The Northern Lights Celilo project proposes a Direct Current (DC) line from Fort McMurray, Alberta to Celilo (near The Dalles in Oregon). There are project alternatives that would extend the line to San Francisco or provide interconnection to the southern Alberta wind fields. The project sponsor is NorthernLights. The capacity of the line is expected to be around 3,000 MW.

- The Canada/Pacific Northwest to Northern California Transmission Project will provide additional capacity between the Northwest and Canada. The line is planned to be an Extra High Voltage (EHV) transmission project between British Columbia and Northern California. Pacific Gas and Electric, Avista and PacifiCorp are the project sponsors. The capacity range is between 1,500 and 4,500 MW.

- The Juan de Fuca Cable project will connect Victoria, B.C. with Port Angeles, WA. The High Voltage Direct Current (HVDC) Light® submarine cable capacity is 550 MW. The sponsor of this project is Sea Breeze.

The capital costs for these large and expensive projects range from just under one billion to several billion dollars. Although there is support, the significant costs, timelines, environmental impacts, and permitting requirements make completion of these projects challenging at best. At this time, it is unclear whether any of the projects will be successfully completed.

7 PLAN DEVELOPMENT AND ANALYSIS

The PUD's Integrated Resource Plan was developed by analyzing six resource portfolios, each designed to meet different load and economic conditions. From this evaluation, a single plan was formed, which considered cost, reliability, risk, legal, and operational criteria.

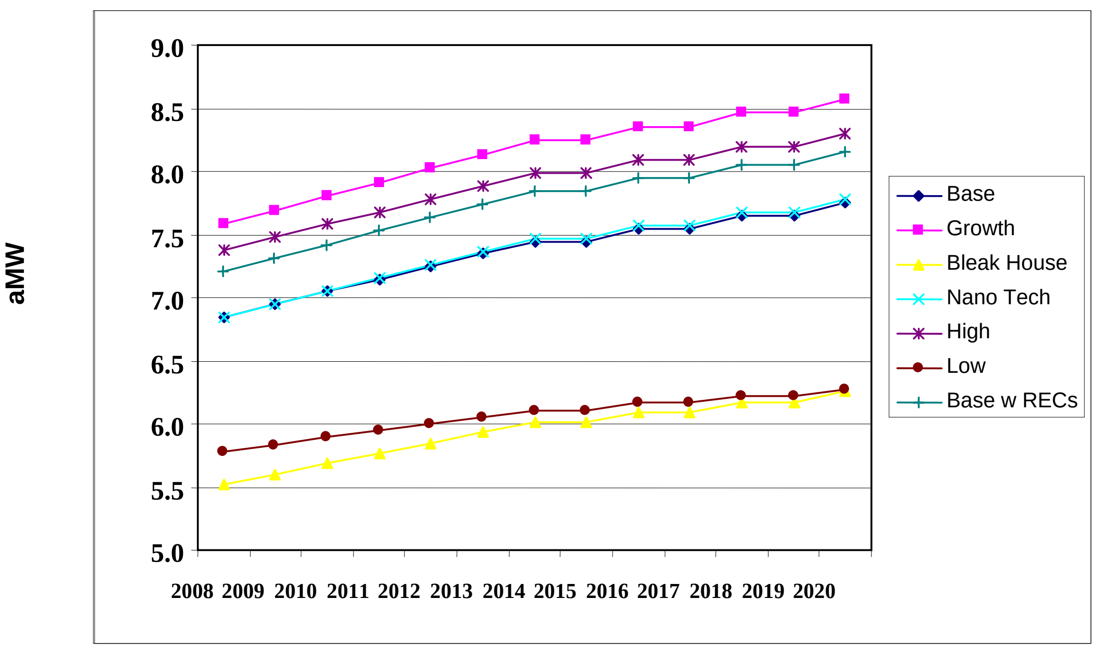
The six resource portfolios match the three scenarios and three load forecasts described in Section 3. The process used to construct them was the same for all cases. The first step involved identifying the conservation programs that are cost effective and the timing for achievement of savings. The remaining resource shortfall was filled using a set of power supply options, prioritized based on resource availability and operational factors.

Conservation

Figure 7-1 shows the amount of conservation found to be cost-effective and achievable for each scenario.

Figure 7-1

Maximum Achievable Conservation Potential
aMW



In the Base Case, efficiency programs reduce loads by 6.8 aMW in 2008. The level of achievable new conservation increases over time, reaching 7.8 aMW in 2020. All cases show a similar pattern, with a gradual and relatively steady rise. Savings are highest in the "Growth and Consequences" scenario. This is due to a combination of economic growth and high avoided costs. The program impacts in the High Case reflect modest increases in efficiency potential in the industrial sector, as increased industrial load drives that scenario.

The line labeled Base w/RECs shows cost-effective conservation using green avoided energy costs.[1] Under these assumptions, roughly 5% more energy efficiency is economic and achievable than under the Base Case. Some of the measures that make up this additional potential include:

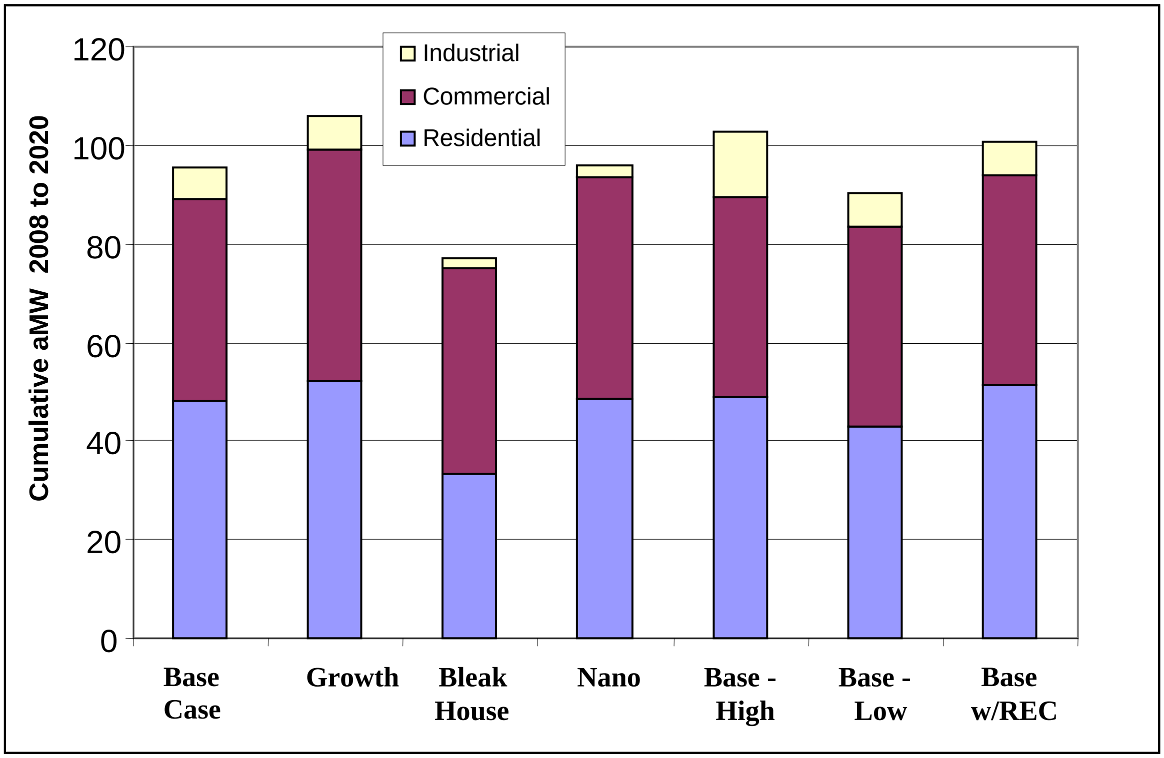
- Advanced efficiency heat pumps
- Air-to-air heat exchangers
- Whole house air sealing
- Advanced lighting technologies and controls
- 80-plus power supply for computers and servers

The amount and mix of resources available depends on the sector level usage forecast and the value of the conservation based on avoided costs. Figure 7-2 below shows the maximum achievable efficiency potential (cumulated from 2008 through 2020) by sector across the various scenarios.

[1] See Section 5.

Figure 7-2

Cumulative Achievable Conservation by Sector*
aMW



*As measured at the customer's meter.

In the Base Case, 96 aMW, or 46% of the PUD's future load growth, is met through conservation. This level is slightly higher than all of the PUD's achievements to date (which as of December 2007 totaled 86 aMW). Half of the savings come from residential customers, whose load accounts for just under half of the PUD's retail sales. Commercial customers account for most of the remaining potential. Industrial conservation is highly dependent on the level of industrial load, which varies significantly across scenarios.

Prioritized Power Supply Options

Once the achievable conservation levels were determined, staff crafted a resource portfolio for each case by adding power supply resources—drawn from a menu of available and prioritized options:

1. BPA
2. Small Hydro
3. Biomass/Landfill Gas
4. Tidal Energy and Geothermal Power
5. Wind Resources

BPA Tier 1 and Tier 2 Power

In 2011, BPA will offer two types of power contracts—Tier 1 power from existing federal system resources and Tier 2 power composed of resources added to meet incremental loads preference customers may wish to place on BPA. The rates for both types of power will be based on actual costs. Tier 1 rates will reflect the region's past investment in low cost hydro and nuclear plants, and while there will be some pressure on BPA operations, Tier 1 rate levels should be similar in magnitude to today's low-cost Priority Firm rates. The cost of Tier 2 power will not be known until the portfolios or resources are constructed.

For planning purposes, staff assumed BPA will continue to sell the PUD 706 aMW under a 50/50 Block/Slice contract arrangement. In 2011, the PUD's allocation will rise by 50 aMWs, when the new contract goes into effect and the PUD's sale of the Centralia power plant can be recognized for the first time. Beginning in 2018, the amount of power available from BPA was forecasted to decline slightly, reflecting the age of power plants and the likelihood that new obligations will reduce the capability of the federal hydro system.

Utilities wishing to purchase Tier 2 resources must provide BPA with a commitment no later than November 2009. Without that commitment, a utility will lose the opportunity to purchase a "Vintage Tier 2" product in the future. To preserve the Tier 2 option, a three year Short Term Tier 2 contract of 5 aMW was added to every portfolio.

Small Hydro

Staff ranked small and low-impact hydro as the next most desirable resource after BPA Tier 1 power. Although the potential is not large, there are sites within the PUD's service territory that could be developed with proper regard for the environment. One such project was submitted in response to the PUD's Renewables RFP and staff is aware of other small opportunities.

The locations of these projects offer several advantages. First, plant operation and maintenance would be easy to carry out because the PUD could rely and build upon staff expertise already present at the Jackson Hydro Project. Second, power generation inside Snohomish County would contribute positively to system reliability by providing transmission counter-flows and by reducing the amount of power delivered to the PUD from outside the Puget Sound region. While the PUD would need to build transmission infrastructure to reach new sites, these costs would be offset, in part, by reduced BPA transmission costs. Third, the generation profile of small low-impact hydro mirrors the PUD's load requirements—local hydro generation is highest in winter months when heating needs drive up the demand for electricity.

In addition to local small and low-impact hydro, the PUD can recall its 2 aMW interest in Energy Northwest's Packwood project. The PUD's share of the output is currently serving Franklin and Benton PUDs. While recalling the power could reduce the PUD's 2011 High Water Mark by a like amount, the action would benefit the PUD in the near term. Because staff is already involved in Packwood contract administration and because a small, low-impact hydro strategy will by necessity involve managing a variety of small resources, it seems reasonable to add Packwood to the mix that serves PUD loads. Given this intention, staff included 2 aMW of hydro resources from Packwood in each portfolio beginning in 2009.

Staff also assumed that investment in incremental generation at Jackson would move forward, raising the nameplate capacity rating from 103 MW to 112 MW. The additional energy available under critical water conditions was increased from 29.5 to 31.5 aMW in 2018.

Although less certain, staff believes it can count on some level of additional megawatts from small and low-impact hydro. Another 2 aMW was assumed to come on-line in 2013, followed by 0.5 aMW increment in 2014 and another 0.5 a MW addition in 2016. These conservative assumptions are included in all portfolios.

Biomass and Landfill Gas

Biomass and Landfill Gas were grouped together because they offer similar generation profiles and both use fuel derived from waste streams rather than fossil reserves. The PUD's experience with the Klickitat Landfill Gas contract has been positive. The 5 MW project (4.9 MW with losses) has operated reliably, year after year, with few outages. Staff has notified Klickitat PUD of its desire to renew the existing contract when it expires in 2009. Although there is no guarantee that a mutually acceptable price can be agreed upon, staff has assumed for analytical purposes that the negotiations will be successful.

Klickitat PUD has announced the possibility of building a second facility at the same county landfill. This project would be larger and use combined-cycle generation technology. The PUD has expressed its interest in this project as well, but will face competition for this desirable resource from other utilities.

Throughout the state, there are several biomass projects in the early stages of planning. These projects will use household compost, garden litter or agricultural waste as their primary feedstock. None of these projects is certain, however, and their possible success depends on the ability of developers to obtain fuel sources and negotiate power prices that make electricity generation more attractive. For planning purposes, staff assumed the PUD could obtain an additional 5 aMW from either landfill gas or biomass sources as early as 2012. In 2020 another 10 aMW would become available. These assumptions were held constant for all portfolios.

Tidal Energy

Fourth in order of preference is Tidal Energy. The PUD has taken a leadership role in the research and development of hydrokinetic energy in Puget Sound. This resource is attractive because it is renewable, predictable and available in the PUD’s backyard.

Under the current research plan, the PUD will place its first pilot plant in Puget Sound waters around the summer of 2012. A year or more of study will be needed before the PUD could confidently place additional devices in the water; and then more studies would be needed to design and build grid interconnections. If no problems or challenges are encountered, and assuming costs decline as the technology becomes more fully understood, 2015 is the earliest point in time that tidal energy could be included in the PUD’s IRP. Staff assumed 1 aMW of energy would be available in 2015. This amount increases gradually to 5 aMW by the year 2020.

Geothermal Power

Geothermal power is tied with tidal energy in order of preference. While geothermal holds great promise as a baseload, renewable, resource located within the PUD’s service territory, the challenges associated with development are not yet fully known. No plants have ever been permitted in Washington state. And while there is evidence that geothermal resources exist within the Snohomish County area, staff does not know if it will be successful in finding suitable geology at a reasonable cost.

Enhanced geothermal systems (EGS) eliminate the need for sites with perfect combinations of heat, water and rocks. Instead, suitable sites can be engineered to enable heat transfer that can be used to generate electricity. But this new technology has yet to be applied on a large scale and the PUD would be a pioneer.

That said, other than wind, geothermal represents the only resource type potentially available in enough quantity to meet the PUD’s I-937 obligations. The operating characteristics of geothermal are far superior to wind—it can operate as a baseload resource (with some ability to ramp up and down) and the technology is proven, having many years of operating history throughout the world. In addition, the costs (currently estimated at 7 to 10 cents/kWh) are in line with the cost of wind when the wind integration, firming and shaping charges are taken into account.

For the Base Case, staff assumed the development of geothermal would ideally begin with one small 10 MW project coming on-line in 2015. That project would be expanded to 30 MWs the following year. If need be, the initial plant could be brought on-line at the full 30 MW. Future plants were assumed to be added at different sites in increments of 30 MW or 50 MW as dictated by the load growth forecasted associated with each case.

Wind

The responses to the PUD's Request for Proposals revealed that enough wind energy is available from independent developers to satisfy all of the PUD's I-937 targets. Still, staff ranks wind as the PUD's least desirable resource. Section 6 outlines the many operational challenges associated with wind. In addition, the cost of new wind projects has increased substantially in recent months, due to a worldwide shortage of steel and a deteriorating U.S. dollar exchange rate. In 2009, BPA Transmission Services will begin charging wind owners for integration services. The rate to be applied resulted from a settlement process and is likely to rise once BPA completes studies examining the actual costs of integration. Based on both operational and cost considerations, wind appears to be a poor long-term choice compared to the potential benefits of geothermal power.

In the interim, staff is actively negotiating with several wind developers for contracts that will fulfill near-term load and I-937 requirements. Of these negotiations, two are nearly complete, with contracts expected to be presented to the Board by the end of July. A third contract is currently being worked out. This contract will bring the total energy expected from new wind sources to roughly 60 aMW. The timing of these resources is as follows: 16 aMW online beginning early 2009, an additional 28 aMW in mid-2009, and lastly 16 aMW following in January, 2010.

For portfolio planning, wind was assumed to be an unlimited resource, but constrained in two ways. Knowing the time necessary to negotiate long-term contracts, it is unlikely the PUD could procure additional wind energy before 2011. The second, self-imposed constraint, limits wind to no more than 10% of the PUD's portfolio. This level is deemed the maximum amount the Power Scheduling department can reasonably manage, given the limited flexibility of the PUD's existing resources. In scenarios with relatively low load growth, where fewer resources are needed overall, only two of the three wind contracts currently under negotiation were assumed to be in place.

Alternative Portfolios

Table 7-1 presents the capability of the PUD's existing resources over time. These figures underlie Tables 7-2 through 7-8 where the portfolios corresponding to each case are presented. For planning purposes, the output associated with the Jackson project and the Block/Slice contract assumes critical water conditions.

Table 7-1

Capability of Existing Resources
aMW

Existing Resources													
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
BPA block & slice	706.0	706.0	706.0	706.0	706.0	706.0	706.0	706.0	706.0	706.0	692.0	678.0	665.0
Jackson hydro	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	31.5	31.5	31.5
KC Co-gen	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	0.0	0.0	0.0
White Creek Wind	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Klickitat LFG	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hampton co-gen	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
Morgan Stanley	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Line Losses and PSE Trans.	(17.6)	(17.6)	(8.5)	(6.8)	(6.8)	(6.8)	(6.8)	(6.8)	(6.8)	(6.8)	(6.5)	(6.3)	(6.0)
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5

*Resources at Critical Water

Base Case Portfolio

Under the Base Case (Table 7-2), the PUD is deficit under critical water conditions until 2012, when new BPA Tier 1 and Tier 2 contracts add 55 aMW to the PUD's resource mix (with losses considered, this amount translates to 54.1 aMW). The portfolio shows a slight surplus position for the remainder of the period. Modest hydro additions come into play in 2013 and 2014. Then, starting in 2015, geothermal power picks up most of the PUD's load growth.

Near-term deficits are met with short-term purchases from the wholesale power market. A new wind contract could be justified to meet load in 2011, but would produce more energy than necessary once the new BPA contracts go into effect.

Table 7-2

Base Case Portfolio
aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	818.5	841.1	861.9	879.9	895.5	912.2	926.0	940.1	951.1	968.8	983.6	998.6	1011.1
Conservation	(7.2)	(14.2)	(21.2)	(28.4)	(35.6)	(43.0)	(50.4)	(57.9)	(65.4)	(73.0)	(80.6)	(88.3)	(96.0)
Adjusted Load	**811.2**	**826.9**	**840.7**	**851.5**	**859.8**	**869.2**	**875.6**	**882.2**	**885.6**	**895.8**	**903.0**	**910.4**	**915.1**
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	54.1	54.0	54.0	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	29.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	30.0	30.0	60.0	90.0	90.0
Total New Resources	**0.0**	**31.0**	**64.9**	**64.9**	**123.8**	**125.7**	**126.2**	**132.3**	**152.8**	**153.8**	**183.8**	**213.8**	**226.8**
Short Term Market Trans.	(20.3)	(5.0)	(5.8)	(14.9)	35.7	28.2	22.3	21.8	38.9	29.7	2.8	11.7	7.2
I-937 Surplus RECs	11.0	40.0	68.9	68.9	67.6	67.3	67.6	78.4	45.7	45.8	74.1	103.5	61.1

Includes Losses

I-937 renewable resource targets are met or exceeded in every year in the Base Case portfolio (Table 7-3). In 2012, the targets call for 26 aMW from eligible renewables. The Base Case plan would bring on 94 aMW by that date, including the PUD's Hampton and White Creek contracts, and assuming 20 aMW of Renewable Energy Credits flow to the PUD from BPA. In 2016, the PUD would have 125 aMW of eligible renewables and in 2020, the PUD could count on 198 aMW to meet its 137 aMW target.

Table 7-3

Base Case I-937 Requirements
aMW

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	818	841	862	880	895	912	926	940	951	969	984	999	1011
Conservation	(7)	(14)	(21)	(28)	(36)	(43)	(50)	(58)	(65)	(73)	(81)	(88)	(96)
Adjusted Load	**811**	**827**	**841**	**852**	**860**	**869**	**876**	**882**	**886**	**896**	**903**	**910**	**915**
I-937 % Requirement	0%	0%	0%	0%	3%	3%	3%	3%	9%	9%	9%	9%	15%
I-937 Requirement (aMW)	**0**	**0**	**0**	**0**	**26**	**26**	**26**	**26**	**80**	**81**	**81**	**82**	**137**
Existing Renewables													
White Creek Wind I	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Klickitat LFG	4.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hampton Biomass*	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
New Renewable Resources													
BPA RECs	0.0	0.0	0.0	0.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
New Wind Resources	0.0	29.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	30.0	30.0	60.0	90.0	90.0
Total Renewables for I-937	11	40	69	69	94	94	94	105	125	125	155	185	198
I-937 Surplus RECs	**11**	**40**	**69**	**69**	**68**	**68**	**67**	**78**	**45**	**44**	**73**	**103**	**60**

*Option to purchase RECs

Low Case Portfolio

In the Low Case (Table 7-4), loads fall below today's current levels and stay low throughout the planning horizon. Under these circumstances, I-937 requirements drive resource additions. Beyond the two wind contracts soon to be before the Board, the PUD would need no additional power supplies to meet loads, but would be without enough renewable resources to meet I-937 targets. The Low Case portfolio assumes the existing Klickitat LFG contract is extended, but no new biomass contracts are pursued. The PUD would continue to develop small low-impact hydro and tidal energy opportunities. Geothermal generation would come on-line in 2016.

Table 7-4

Low Case Portfolio
aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	807.6	824.9	841.6	855.6	867.2	878.8	888.1	897.7	904.2	918.2	929.6	941.0	950.1
Conservation	(6.2)	(12.0)	(17.9)	(23.8)	(29.8)	(35.9)	(42.0)	(48.1)	(54.3)	(60.4)	(66.7)	(72.9)	(79.1)
Adjusted Load	**801.5**	**812.9**	**823.7**	**831.8**	**837.4**	**842.9**	**846.2**	**849.6**	**850.0**	**857.7**	**862.9**	**868.1**	**870.9**
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	54.0	54.0	54.0	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	29.0	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	14.9
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	30.0	60.0	60.0	60.0
Total New Resources	**0.0**	**31.0**	**50.2**	**50.2**	**104.1**	**106.1**	**106.6**	**102.7**	**133.2**	**134.2**	**164.2**	**164.2**	**177.2**
Short Term Market Trans.	(10.5)	9.1	(3.5)	(9.9)	38.4	34.9	32.2	24.8	55.0	48.2	23.3	4.3	1.8
I-937 Surplus RECs	11.0	40.0	54.2	54.2	48.7	48.5	48.9	49.8	29.3	29.6	58.1	57.7	18.2

High Case Portfolio

In the High Case loads increase dramatically, requiring additional wind resources and significant new power supplies every two years or less. By 2020, the PUD would find itself relying on 170 MW of geothermal power to meet loads.

Table 7-5

High Case Portfolio
aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	845.6	878.7	905.0	928.4	949.5	986.7	1005.3	1024.3	1039.0	1059.8	1094.8	1119.1	1138.9
Conservation	(7.8)	(15.2)	(22.8)	(30.5)	(38.3)	(46.2)	(54.1)	(62.1)	(70.2)	(78.3)	(86.5)	(94.7)	(103.0)
Adjusted Load	**837.8**	**863.5**	**882.2**	**897.9**	**911.3**	**940.5**	**951.2**	**962.2**	**968.7**	**981.5**	**1008.3**	**1024.4**	**1035.9**
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	69.1	69.1	69.1	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	29.0	58.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	30.0	30.0	60.0	60.0	140.0	170.0	170.0
Total New Resources	**0.0**	**31.0**	**64.9**	**104.9**	**178.8**	**180.8**	**211.3**	**192.3**	**222.8**	**223.8**	**303.8**	**333.8**	**346.8**
Short Term Market Trans.	(46.9)	(41.6)	(47.3)	(21.4)	39.3	12.0	31.9	1.9	25.8	14.0	17.5	17.7	6.4
I-937 Surplus RECs	11.0	40.0	68.9	108.9	106.1	105.2	135.4	136.0	108.2	108.1	184.7	213.2	163.0

Growth and Consequences Portfolio

The Growth and Consequence scenario is similar to the Base Case, but with loads increasing at a slightly higher growth rate. Near-term energy shortfalls, and required wholesale market purchases, range from 20 to 39 aMW. An additional 30 MW geothermal plant is needed in 2018.

Table 7-6

Growth and Consequences
aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	825.8	858.1	888.6	906.8	922.5	939.4	953.4	967.7	978.8	996.7	1011.8	1026.9	1039.5
Conservation	(8.0)	(15.6)	(23.4)	(31.4)	(39.4)	(47.5)	(55.8)	(64.0)	(72.4)	(80.7)	(89.2)	(97.6)	(106.2)
Adjusted Load	**817.8**	**842.5**	**865.2**	**875.4**	**883.1**	**891.9**	**897.7**	**903.7**	**906.4**	**916.0**	**922.6**	**929.3**	**933.3**
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	54.0	54.0	54.0	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	29.1	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	30.0	30.0	80.0	110.0	110.0
Total New Resources	**0.0**	**31.1**	**64.9**	**64.9**	**123.7**	**125.7**	**126.2**	**152.3**	**152.8**	**153.8**	**203.8**	**233.8**	**246.8**
Short Term Market Trans.	(26.9)	(20.5)	(30.3)	(38.8)	12.4	5.5	0.3	20.4	18.1	9.5	3.2	12.8	9.0
I-937 Surplus RECs	11.0	40.1	68.9	68.9	66.9	66.6	67.0	97.8	43.8	44.0	92.4	121.8	78.4

Bleak House Portfolio

The Bleak House portfolio looks similar to the Low Case. The two anticipated wind contracts would be enough to create a nearly balanced portfolio in the short term. Geothermal development would be pushed back several years, but still be needed to meet I-937 targets. In 2020, geothermal would account for 60 aMWs of the PUD's resource portfolio.

Table 7-7

Bleak House Portfolio
aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	773.1	777.0	788.0	798.0	804.6	817.2	826.8	836.3	843.2	855.8	865.8	875.9	883.7
Conservation	(5.9)	(11.5)	(17.2)	(23.0)	(28.8)	(34.7)	(40.7)	(46.8)	(52.8)	(58.9)	(65.1)	(71.3)	(77.5)
Adjusted Load	**767.2**	**765.5**	**770.8**	**775.0**	**775.8**	**782.5**	**786.0**	**789.6**	**790.3**	**796.9**	**800.7**	**804.6**	**806.1**
Existing resources	738.9	738.9	718.0	719.7	719.7	719.7	719.7	719.7	719.7	719.7	670.9	658.3	646.0
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	54.0	54.0	54.0	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	29.0	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	30.0	30.0	60.0	60.0
Total New Resources	**0.0**	**31.0**	**50.2**	**50.2**	**104.1**	**106.1**	**106.6**	**102.7**	**113.2**	**134.2**	**134.2**	**164.2**	**167.2**
Short Term Market Trans.	(28.3)	4.4	(2.6)	(5.1)	48.1	43.3	40.3	32.8	42.6	57.0	4.4	17.9	7.1
I-937 Surplus RECs	11.0	40.0	54.2	54.2	50.5	50.3	50.7	51.6	14.7	35.1	33.7	63.4	17.9

Tech Goes Nano Portfolio

Although different forces drive the “Tech Goes Nano” scenario, the power supply portfolio attached to this future looks very similar to the Low Case. While loads grow moderately, technology creates energy savings opportunities, with the result that the post-conservation loads are lower in the Tech Goes Nano world than in any other case. I-937 renewable targets drive the addition of new power supplies. By 2020, the portfolio contains 30 aMW of geothermal generation.

Table 7-8

Tech Goes Nano
aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	816.3	831.5	845.0	850.1	851.0	854.6	855.5	856.0	856.3	862.9	872.2	881.7	889.0
Conservation	(7.2)	(14.2)	(21.2)	(28.4)	(35.6)	(43.0)	(50.5)	(57.9)	(65.5)	(73.1)	(80.8)	(88.4)	(96.2)
Adjusted Load	**809.1**	**817.4**	**823.7**	**821.7**	**815.4**	**811.6**	**805.0**	**798.1**	**790.8**	**789.8**	**791.4**	**793.2**	**792.8**
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5
BPA (Tier 1 and 2)	0	0	0	0	54	54	54	49	49	49	49	49	49
Wind Resources	0.0	29.0	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
Total New Resources	**0.0**	**31.0**	**50.2**	**50.2**	**109.0**	**111.0**	**111.5**	**107.6**	**108.1**	**109.1**	**109.1**	**109.1**	**152.1**
Short Term Market Trans.	(18.2)	4.5	(3.6)	0.1	65.4	71.1	78.2	81.3	89.0	91.0	39.7	24.1	54.8
I-937 Surplus RECs	11.0	40.0	54.2	54.2	54.2	54.3	55.0	56.3	9.5	10.6	9.5	9.3	4.8

Portfolio Comparisons

The portfolios contain many common elements. All six cases include 50 aMW of additional BPA Tier 1 power, 5 aMW of Tier 2, and 5 aMW of tidal. They differ from one another by the amount of conservation, biomass, wind, and geothermal resources brought on-line. Table 7-9 presents a snapshot of resource types for the year 2020.

Table 7-9

Snapshot of 2020 Resource Mixes
aMW

	Conservation	BPA (Tier I & 2)	Small Hydro	Tidal	Wind Resources	Biomass and LFG	Geothermal
Base	96.0	49.1	5.0	5.0	58.0	19.8	90.0
Low	79.1	49.1	5.0	5.0	43.5	14.9	60.0
High	103.0	49.1	5.0	5.0	98.2	19.8	170.0
Growth	106.2	49.1	5.0	5.0	58.2	19.8	110.0
Bleak House	77.5	49.1	5.0	5.0	43.5	4.9	60.0
Tech Goes Nano	96.2	49.1	5.0	5.0	43.5	19.8	30.0
Preferred Plan	96.0	49.1	5.0	5.0	58.0	19.8	90.0

Conservation (cumulative from 2008 through 2020) varies from 77 aMW to 106 aMW, reflecting each scenario's different assumptions about avoided costs and energy-efficiency opportunities. In the Low, Bleak House and Tech Goes Nano cases, no additional wind beyond the 44 aMW currently under negotiation is needed, and geothermal resources are scaled back to as low as 30 aMW, just enough to enable the PUD to meet I-937 requirements.

Table 7-10 shows the range of costs and rate measures for each scenario.

Table 7-10

Net Present Value (NPV) of Total Cost and Cumulative Rate Pressure

Portfolio	NPV ($millions)	2012	2016	2020
Base Case	$3,438	0.8%	8.3%	23.5%
Low Case	$3,229	-1.6%	5.6%	19.7%
High Case	$3,685	-1.4%	6.9%	23.2%
Growth and Consequences	$3,570	1.5%	9.4%	24.0%
Bleak House	$3,120	0.9%	7.4%	20.3%
Tech Goes Nano	$3,018	-3.1%	0.5%	17.4%

The costs of carrying out these plans, in net present value terms, ranges from $3.0 billion to $3.6 billion (through the year 2020). Average energy rates could rise from roughly 4.0 cents/kWh today by as much as 1.7 cents/kWh under the Growth and Consequences scenario.

Risk Analysis

One of the main risks within each portfolio comes from the variable nature of Slice generation. To measure this impact, each portfolio was evaluated using data for BPA's hydro system representing 70 years of historical generation. This variability and the resulting impact on power prices leads to a probability distribution of average power costs for each portfolio. One way to access the risk associated with each portfolio is to indicate a range of possible outcomes. The following table characterizes the risks by showing the range between the 90th percentile and the 10th percentile of the individual distributions for the year 2016.

The numbers in Table 7-11 show how much average power costs would change from a very low water year to a very high water year. In the Base Case the average costs in the low water case would be $10.57 higher than in the high water case. The high-risk figures for the Growth and Consequences case and the Tech Goes Nano case come about from an assumption of greater market price volatility in those scenarios.

Table 7-11

Risk Metric
Range between 90th and 10th percentiles of Average Cost

Portfolio	**2016** ($/MWh)
Base Case	$10.57
Low Case	$10.72
High Case	$10.36
Growth and Consequences	$16.49
Bleak House	$11.03
Tech Goes Nano	$17.20

Preferred Plan

To develop a Preferred Plan, staff evaluated how the Base Case resource portfolio would perform under the other five futures. In the Low, Bleak House and Nano worlds, the Base Case portfolio could be adjusted easily by delaying geothermal and tidal investments until needed for load growth or I-937 renewable targets. If loads were to increase as in the Growth and High Cases, the PUD would have several options: move geothermal development forward, increase reliance on wholesale power markets, contract for added wind energy, or purchase Tier 2 power from BPA. There are risks and challenges with each of these paths.

Once a schedule for geothermal development is established and work is underway, it may be difficult to accelerate construction. Increased dependence on wholesale power markets would raise the PUD's exposure to volatile energy prices, which if markets de-stabilize could negatively impact rates. Additional wind energy, beyond that in the Base Case portfolio, would be difficult to absorb into the PUD's resource mix and require firming and shaping contracts. It is not clear the extent to which firming and shaping contracts will be available in the future and at what price. And while Tier 2 could be an option, the PUD would need to identify its expected shortfall far enough in advance to provide BPA with its required three-year notice period.

Given these concerns, it seems reasonable to adjust the Base Case portfolio and add flexibility by moving forward the start date of the first geothermal resource. While this change brings on resources in advance of need, it provides insurance against higher than expected loads. In addition, and more importantly, it gives the PUD time to re-group if the development of geothermal encounters obstacles. There are currently no commercial geothermal projects in Washington State. With this resource plan, the PUD would be taking a lead role in hydrothermal and enhanced geothermal systems. Starting today, with a target on-line date of 2014, would enable the PUD to know—as soon as possible—if it can rely on geothermal technology to meet the long-term needs of its customers.

Table 7-12 presents the Preferred Plan, with the first geothermal plant moved forward.

Table 7-12

Preferred Plan
aMW

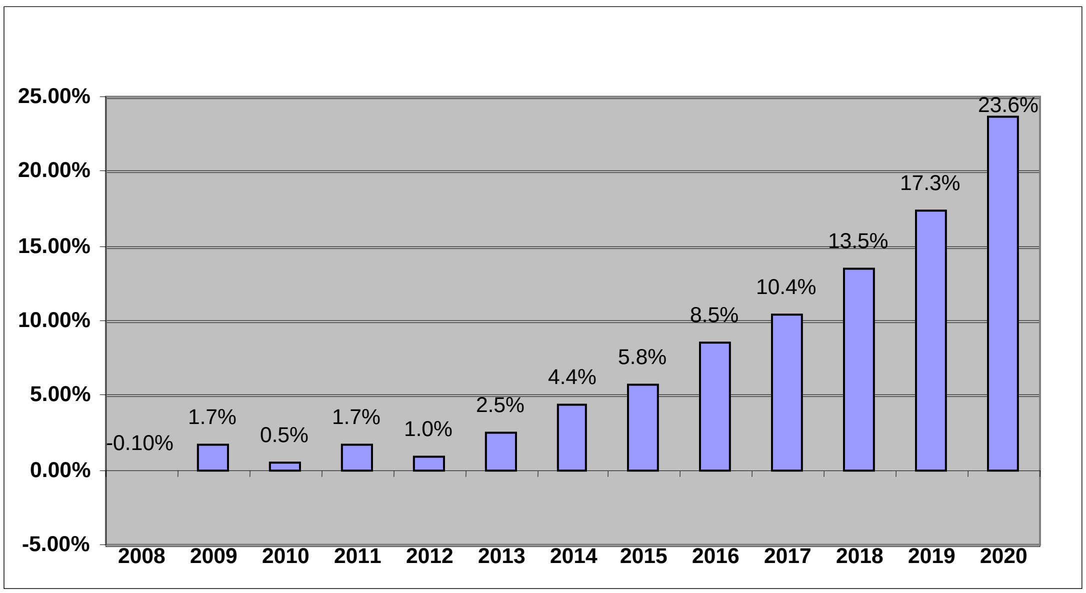
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	818.5	841.1	861.9	879.9	895.5	912.2	926.0	940.1	951.1	968.8	983.6	998.6	1011.1
Conservation	(7.2)	(14.2)	(21.2)	(28.4)	(35.6)	(43.0)	(50.4)	(57.9)	(65.4)	(73.0)	(80.6)	(88.3)	(96.0)
Adjusted Load	**811.2**	**826.9**	**840.7**	**851.5**	**859.8**	**869.2**	**875.6**	**882.2**	**885.6**	**895.8**	**903.0**	**910.4**	**915.1**
Existing resources	790.9	790.9	770.0	771.7	771.7	771.7	771.7	771.7	771.7	771.7	722.0	708.2	695.5
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	54.1	54.0	54.0	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	29.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0	30.0	30.0	60.0	90.0	90.0
Total New Resources	**0.0**	**31.0**	**64.9**	**64.9**	**123.8**	**125.7**	**136.2**	**132.3**	**152.8**	**153.8**	**183.8**	**213.8**	**226.8**
Short Term Market Trans.	(20.3)	(5.0)	(5.8)	(14.9)	35.7	28.2	32.3	21.8	38.9	29.7	2.8	11.7	7.2
Surplus or Shortfall RECs	11	40	69	69	68	67	78	78	46	46	74	103	61

The Preferred Plan is fully compliant with I-937. It incorporates and relies on 96 aMW of new cost-effective energy conservation and it meets or exceeds all renewable requirements. Incremental power supplies include a diversified mix of contracts with third party providers, BPA power, and resources owned and operated by the PUD. If loads were to grow slower than expected, the PUD could reduce the pace of geothermal development. If loads were to grow faster than expected, the PUD could meet customer demands without undue reliance on wholesale energy markets. If the PUD's geothermal efforts were to encounter setbacks, there would be enough time to create alternate plans.

In terms of cost, the Preferred Plan is slightly more expensive than the Base Case portfolio, with a net present value cost of $3.4 billion. The impact on rates is shown in Figure 7-3.

Figure 7-3

Cumulative Rate Pressure



The rate analyis assumes annual costs of conservation averaging $18.1 million per year, not including customer conservation loans; and BPA rate increases of 2% in 2010 and 2% in 2012, followed by rate increases equal to inflation (2.5%) in every year throughout the study period.

The PUD will need capital for the small hydro, tidal and geothermal projects before the power is actually generated. Staff assumed that it would take three years to build each plant and each would be financed upfront. Alternately, other borrowing streams could be used. The capital costs associated with the Preferred Plan are shown below.

Table 7-13

Preferred Plan Generation System Capital Requirements
($000)

Year	Tidal	Geothermal	Small Hydro Project	Total
2008	$0	$0	$0	$0
2009	$0	$0	$30,000	$30,000
2010	$0	$0	$0	$0
2011	$0	$61,260	$0	$61,260
2012	$8,279	$0	$0	$8,279
2013	$0	$128,723	$0	$128,723
2014	$8,698	$0	$0	$8,698
2015	$0	$202,859	$0	$202,859
2016	$0	$207,931	$0	$207,931
2017	$28,099	$0	$0	$28,099
2018	$0	$0	$0	$0
2019	$0	$0	$0	$0
2020	$0	$0	$0	$0
Total	$45,076	$600,773	$30,000	$675,848

Preferred Plan vs a Market-Only Strategy

Staff compared the cost of the Preferred Plan with a portfolio that relied only on conservation, BPA Tier 1 power and short-term wholesale power markets. I-937 renewable targets were met by purchasing Renewable Energy Credits. The net present value cost of this approach is $3.3 billion or roughly 0.03% lower than the Preferred Plan. This difference is small and staff believes not enough to justify the risk associated with a “Market-Only” strategy. While costs are lower on average, the figures contain more uncertainty than other calculations.

Taking this path would subject PUD rates to the ups and downs of power markets, as well as Renewable Energy Credit markets. Staff’s forecast of Renewable Energy Credit prices is uncertain. It is expected that the demand for Renewable Energy Credits will be high because several utilities in Washington and California are counting on Renewable Energy Credit purchases to meet state renewable portfolio standards. To rely on Renewable Energy Credits, rather than building renewable resources, may be appropriate for utilities experiencing little or no growth. But, given the PUD's supply deficit, new contracts and development of PUD-owned renewable resources appears to be a safer path.

Preferred Plan without I-937

I-937 contains language designed to limit the legislation's rate impacts. Utilities need not add renewables beyond a point that would increase rates more than 4% above a plan without I-937 requirements. However, given the PUD Commission's directive to pursue Tier 1 BPA power, cost-effective conservation and renewable resources, it is difficult to see how the Preferred Plan would have looked different if I-937 had not been enacted.

Preferred Plan with Conservation Stretch Goals

Table 7-14 incorporates conservation stretch goals into the Preferred Plan. These goals reflect the "Base Case w/ RECs" analysis, where cumulative savings from energy-efficiency programs reach 101 aMW in 2020. These conservation achievements could serve as a replacement for tidal energy, if the PUD's research efforts do not bear fruit. Alternatively, "stretch" conservation could be used to reduce the size of future biomass or geothermal resources.

Table 7-14

Preferred Plan with Stretch Goals

aMW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	818.5	841.1	861.9	879.9	895.5	912.2	926.0	940.1	951.1	968.8	983.6	998.6	1011.1
Conservation	(7.6)	(14.9)	(22.3)	(29.9)	(37.5)	(45.2)	(53.1)	(60.9)	(68.9)	(76.8)	(84.9)	(92.9)	(101.1)
Adjusted Load	**810.9**	**826.2**	**839.6**	**850.0**	**858.0**	**867.0**	**872.9**	**879.2**	**882.2**	**891.9**	**898.8**	**905.7**	**910.0**
Existing resources	790.7	790.3	768.4	769.8	769.5	769.2	768.9	768.6	768.4	768.1	717.1	702.8	689.6
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	54.1	54.0	54.0	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	14.3	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	2.0	2.0	4.0	4.5	4.5	5.0	5.0	5.0	5.0	5.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0	30.0	30.0	60.0	90.0	90.0
Total New Resources	**0.0**	**16.3**	**64.9**	**64.9**	**123.8**	**125.7**	**136.2**	**132.3**	**152.8**	**153.8**	**183.8**	**213.8**	**226.8**
Short Term Market Trans.	(20.1)	(19.6)	(6.3)	(15.4)	35.3	27.9	32.2	21.8	39.1	30.0	2.2	11.0	6.4

Peak Capacity of the Preferred Plan

Until recently, the ability of the federal hydro system along with other utility resources to meet peak demands has largely been taken for granted. Planners focused on generation under critical water conditions and set adequacy standards based on average annual loads. There is a growing realization, however, that the capacity of the region is not limitless and that with increasing populations and greater constraints placed on the operation of dams and rivers, the region could soon find it difficult to meet peak demands. This concern was brought home on July 24, 2006, when a West-Coast-wide heat wave combined with unexpected plant outages caused power markets to dry up. The PUD and other Washington utilities made it through the day by appealing directly to customers for voluntary emergency cutbacks.

To assess how the Preferred Plan would position the PUD to meet peak loads, staff compared the maximum capability of PUD resources under blend water conditions to the single highest hourly load forecast for each year. In 2007, the PUD saw a peak demand in January of 1,417 MW. The PUD's highest demand on record, 1,602 MW, occurred in December 1990 when an Arctic Express hit the Northwest and stayed for several days.

Table 7-15 shows that peak demands (under normal winter conditions) are expected to rise from 1,442 MW in 2008 to 1,693 MW in 2020. Contributions from conservation reduce loads by up to 164 aMW, because the savings associated with PUD's programs are more pronounced in the winter. Even so, market purchases ranging from 14 to 140 MW would be needed to fill the shortfall.

Table 7-15

Preferred Plan Peaking Capacities
MW

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load Commitment	1442.5	1465.6	1496.4	1521.8	1542.8	1566.0	1583.7	1601.8	1614.7	1638.6	1657.6	1677.0	1693.4
Conservation	(12.4)	(24.2)	(36.2)	(48.4)	(60.8)	(73.4)	(86.1)	(98.8)	(111.8)	(124.7)	(137.8)	(150.9)	(164.2)
Adjusted Load	**1430.1**	**1441.4**	**1460.2**	**1473.3**	**1482.0**	**1492.6**	**1497.6**	**1502.9**	**1502.9**	**1513.9**	**1519.8**	**1526.1**	**1529.2**
Existing resources	1,358.4	1,348.7	1,328.4	1,318.7	1,328.4	1,318.7	1,328.4	1,318.7	1,328.4	1,318.7	1,266.9	1,243.7	1,225.9
BPA (Tier 1 and 2)	0.0	0.0	0.0	0.0	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1
Wind Resources	0.0	2.0	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Biomass and Landfill Gas	0.0	0.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	14.9
Small Hydro	0.0	2.0	2.0	2.0	2.0	7.0	7.5	7.5	8.0	8.0	8.0	8.0	8.0
Tidal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	5.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	30.0	30.0	60.0	90.0	90.0
Total New Resources	**0.0**	**4.0**	**15.7**	**15.7**	**69.7**	**74.7**	**75.2**	**86.2**	**106.7**	**107.7**	**137.7**	**167.7**	**180.7**
Short Term Market Trans.	(71.7)	(88.7)	(116.1)	(138.9)	(84.0)	(99.3)	(94.1)	(98.1)	(67.9)	(87.6)	(115.2)	(114.7)	(122.6)

There are many questions to be answered before the PUD can determine if this situation is acceptable or requires action. For example: Do other utilities have excess capacity during the PUD's peak load hours and if so, will this power be available to purchase in the market? How should the available capacity of the PUD's resources be measured? How long can hydro resources sustain maximum generation levels? Should the adequacy standard be based on blend water or some other condition? Should it look at a single hour or a sustained demand period as some have suggested? Given the universal desire to reduce carbon emissions, what new options might exist to serve peak loads? What would it cost to operate existing technologies to meet this need?

Many of these questions are being raised and considered by the NWPCC and other regional planners. The PUD will engage in these discussions, with an eye toward determining if and how its resource plans should be adjusted in future IRPs.

8 SUMMARY AND ACTION PLAN

The Preferred Plan

The Preferred Plan was heavily influenced by two PUD Commission guidelines:

- Rank conservation as the resource of choice for meeting load growth. Pursue all cost-effective energy-efficiency measures and look for ways to accelerate the acquisition of savings where possible and economical.

- To meet loads not served by conservation, rely on a diversified portfolio of available low-cost BPA power, contracts for renewable power from third party providers, PUD-owned generating assets and, if attractive, BPA Tier 2 options. The portfolio should be composed of resources that are renewable and, to the extent possible, located in the PUD's service area.

The Preferred Plan raises the PUD's existing commitment to conservation to even higher levels—over the next twelve years, the PUD would more than double the achievements made over the past twenty. In the power supply area, the plan charts a path toward a vertically integrated utility with a growing and diversified resource portfolio. The PUD will add contracts with third party providers and over time rely increasingly on generating assets it owns and operates itself. The details of the plan are presented in Table 8-1.

Table 8-1

Snohomish PUD Preferred Resource Plan
aMW

	2008	2010	2012	2016	2020
Expected Loads	818.5	861.9	895.5	951.1	1,011.1
New Conservation (w/ line losses)	(7.2)	(21.2)	(35.6)	(65.4)	(96.0)
Net Loads after Conservation	**811.2**	**840.7**	**859.8**	**885.6**	**915.1**
Existing Resources[1]:					
BPA Contracts	699.3	699.3	699.3	699.3	659.1
Jackson Hydro	29.5	29.5	29.5	29.5	31.5
Everett Cogeneration	37.0	37.0	37.0	37.0	0.0
Wind (White Creek)	4.9	4.9	4.9	4.9	4.9
Klickitat Landfill Gas	4.9	0.0	0.0	0.0	0.0
Hampton Biomass	1.0	1.0	1.0	1.0	0.0
Market Purchases	24.5	0.0	0.0	0.0	0.0
PSE Conservation Transfer	(10.2)	(1.7)	0.0	0.0	0.0
New Resources[1]:					
BPA Tier 1 and 2	0.0	0.0	54.0	49.0	49.0
New Wind	0.0	58.0	58.0	58.0	58.0
Biomass/Landfill Gas	0.0	4.9	9.8	9.8	19.8
Small Hydro	0.0	2.0	2.0	5.0	5.0
Tidal	0.0	0.0	0.0	1.0	5.0
Geothermal	0.0	0.0	0.0	30.0	90.0
Short/Term Market Purchases	20.3	5.8	(35.7)	(38.9)	(7.2)
Total Planned Resources	**811.2**	**840.7**	**859.8**	**885.6**	**915.1**
% of I-937 Eligible Renewables	1.4%	8.2%	10.8%	14%	21.6%
Renewable Energy Surplus	11	69	68	46	61

[1] Includes line losses, under critical water conditions.

Action Plan

The following 10-part Action Plan outlines the work activities that will be necessary.

1. **Implement all cost-effective energy conservation measures.**

   Conservation is the PUD's first and best option for meeting future load growth. By reducing the demand for electricity, conservation lowers overall power costs, defers the need for additional transmission and distribution capacity and on a regional level reduces the need to operate existing carbon-based generating plants.

   The PUD currently operates a comprehensive set of conservation programs, which contain measures that enable all customers to participate. Over the next twelve years, staff plans to expand and enhance existing programs to deliver 96 aMW of new cost-effective conservation. Successful implementation will require accelerating customer adoption of cost-effective technologies and practices, providing training and assistance to encourage efficient operations and maintenance activities, and working at federal, state and local levels to advance energy efficient codes and standards.

2. **Actively pursue conservation "stretch" goals and continue to seek new opportunities for customers to save energy and reduce demands.**

   Staff has set a stretch goal for conservation over the next 12 years of 5% more than the Preferred Plan's aggressive targets. Strategies for achieving this goal involve understanding better and leveraging customer needs and preferences, trade ally processes, emerging energy-efficiency technologies and innovative delivery mechanisms. Staff will also be investigating interruptible and standby rate options that could be used to reduce the PUD's peak loads.

3. **Work with BPA to establish a 2012-2028 power supply contract that maximizes the benefits of the federal power system to the PUD.**

   The PUD purchases roughly 90% of its power supply requirements from BPA at a cost of over $187 million a year. This one expense represents 31% of the PUD's annual revenue requirements. The PUD is BPA's single largest customer and will remain so well into the future. A primary and critical activity for staff over the next year will be to negotiate a long-term contract to replace the existing agreement that expires in 2011. Under the current schedule, BPA plans to issue a contract offer on August 1, 2008 and will give utilities until December 1, 2008 to determine product choices and execute an agreement.

   After December, staff will be engaged in a series of BPA rate cases and forums where decisions will be made that will impact the prices the PUD pays for federal power. Staff will also evaluate the need for Tier 2 resources in time to meet BPA's November 2009 notice deadline.

4. **Negotiate long-term contracts for renewable resources.**

   Beyond BPA, the Preferred Plan includes approximately 80 aMW of new power supply contracts for renewable resources owned and operated by others. Of these, contract negotiations are close to completion with two companies. The combined project output of the two projects is 44 aMW, with one providing 28 aMW of capacity over a twenty-year term and the other providing 16 aMW for fifteen years. Staff will focus on procuring additional capacity from both wind and biomass/landfill gas sources.

5. **Actively pursue development of geothermal power resources in or near Snohomish County with a target commercial operation date of 2014.**

   The Preferred Plan relies heavily on power production from geothermal energy in Snohomish County. Staff will move expeditiously to explore this potential and, assuming promising sites are confirmed, move to project development. The first step will involve obtaining permits and land rights and drilling exploratory wells. Both hydrothermal and EGS technologies will be pursued. A target date of 2014 for commercial operation of the first plant will give the PUD enough lead-time to adjust plans if geothermal resource development brings unexpected challenges.

6. **Continue research and development of tidal energy systems in Puget Sound.**

The PUD has taken a leading role in the research and development of tidal energy in the Northwest. The study phase of the PUD's work is expected to continue though 2009. Work to date has included measurement of the velocity and direction of tidal currents in Puget Sound, evaluations of different technologies for hydrokinetic energy, assessment of environmental issues and regulatory requirements. The results are being shared and input is being sought from local tribes, environmental groups and interested stakeholders, as well as with technical partners such as BPA, EPRI and the University of Washington. Once the studies are complete, the PUD will evaluate the technical, economic, and environmental viability of a pilot demonstration plant. The target date for a pilot plant is 2011, with 2015 being the earliest date generation would be available on a commercial basis.

7. **Evaluate and, where appropriate, pursue small-scale hydroelectric opportunities in Snohomish County.**

The Preferred Plan envisions a portfolio of small hydro projects that capitalize on the PUD's Jackson project operations and management experience. Beginning in 2009, PUD will recall its 2 aMW interest in the Energy Northwest Packwood project. Negotiations are in progress for the purchase of a promising site in Snohomish County, which could provide another 2 aMW. In spring 2008, PUD purchased an existing small facility at Woods Creek. Staff plans to investigate the potential for additional sites inside the PUD's service territory.

8. Where appropriate, encourage customer-ownership of small-scale resources.

Small scale distributed resources, owned and developed by customers, also fit within the PUD's portfolio. Distributed generation resources count double for meeting I-937 renewable targets. Like other resources located in the PUD's service territory, they eliminate the need to purchase transmission capacity to transport power from distant places.

PUD can encourage customer investment by simplifying the contract and interconnection process and offering a standard published payment stream for electrical output. For projects that have sales opportunities beyond the PUD's borders, the PUD can establish an internal wheeling tariff that enables developers to reach other markets. Staff is currently moving forward on these efforts.

It may make sense for the PUD to offer incentives and otherwise promote customer-owned solar photovoltaic and solar water heating applications. Staff expects to present a package of possible options to the Commission this summer.

9. Participate in regional transmission forums to ensure that adequate transmission capacity is available to deliver BPA and other generating resources to PUD loads.

The PUD will continue to participate in ColumbiaGrid and other transmission planning processes, with a focus on transmission projects that ease congestion in the Puget Sound I-5 corridor, as well as on projects that support Northwest renewables. Staff will actively manage the PUD's existing transmission contracts and participate in BPA's Network Open Season process whenever additional capacity is required. Staff will continue to be a strong supporter and act as a prime mover behind BPA's redispatch pilots—which can prevent load curtailments when transmission systems become strained.

10. **Continue to monitor emerging technologies and further develop staff knowledge, tools and databases used to evaluate both supply and demand-side resource options.**

Staff will continue to track new power supply and energy-efficiency technologies and refine its knowledge base with respect to resource planning. Three specific efforts are currently underway: gaining experience using new planning tools—such as short-term load forecasting and regional power simulation models, carrying out systematic load research on customer usage patterns, and enhancing the PUD's energy-efficiency analytic and implementation capabilities.

APPENDICES

APPENDIX A

GENERAL STRATEGY FOR MEETING FUTURE LOAD GROWTH

In January 2007, the PUD Commission considered the important question of the future role of BPA with respect to serving the PUD's increasing power demands. As a result of that deliberation, the Commission chose to move forward with a portfolio of asset ownership, long-term contracts, and, possibly BPA Tier 2. The exact mix will be determined according to an assessment of cost and other considerations. Consideration of BPA's role was framed by the following discussion.

The role of BPA in the region is expected to change significantly after 2011. In this new setting, BPA may, as in the past, serve the growing electric requirements of the PUD but it will no longer do so at embedded cost. Instead, BPA will allocate to each publicly owned utility a High Water Mark. BPA will then provide power up to a utility's HWM at a Tier 1 rate set to recover the cost of the existing federal system and then, if requested, serve the utility's load growth at the cost of acquiring new supplies or Tier 2. This means there is no longer significant economic advantages for an electric utility to put its entire load on BPA, since the cost of new power supplies will no longer be melded into BPA's rates.

Given this new paradigm, the PUD's future resource strategy can be thought of in terms of three broad categories: BPA Tier 1 allocation, conservation/demand-side management programs, and strategies beyond conservation for meeting the PUD's load growth. With respect to the first two categories staff is working under the assumption that the PUD will pursue as large a share of BPA Tier 1 power as can be justified and aggressively implement all cost-effective conservation and demand-side management options.

While there will continue to be rate pressures brought on by fish, flood control and other federal system obligations, Tier 1 rates should remain relatively stable and below market prices over the foreseeable future. Purchasing as much Tier 1 power as possible will ensure the benefits of the Federal system are retained for PUD ratepayers. An aggressive conservation strategy would carry on the PUD's past successful efforts, is consistent with I-937 requirements, and allows customers to help address load growth.

For meeting the remaining growth, the PUD has several policy options, the choice of which significantly influences the IRP. These options are defined as follows:

1. Rely on BPA Tier 2 resource products for all future needs
2. Build or buy generating assets (alone, with partners, or via Joint Operating Agencies)
3. Purchase long-term power supply contracts from non-federal sources
4. Pursue a combination of 2 & 3 above
5. Pursue a combination of 1, 2 & 3 above.

The following chart briefly summarizes the pros and cons associated with each of these choices:

Option	Pros	Cons
1. BPA Tier 2	- removes load growth responsibility from the PUD - easy to carry out - safe - potentially more stable rates - BPA a known entity - no capital investment required	- all eggs are in one basket - destiny in the hands of BPA - leadership transferred to BPA - internal power supply expertise may be attracted elsewhere - inconsistent with Regional Dialogue position - potentially more costly than other sources
2. Build or buy own resources	- asset ownership a hedge against market risk - potential for lowest possible rates - consistent with a utility our size and scope - in control of destiny - work challenges attract best talent and culture - regional leadership - avoids involvement in BPA Tier 2 issues	- development risk – financial, regulatory, lead time, etc. - risk of no project prospects - potentially highest cost option - limits resource diversity, perhaps - capital investment required - load growth responsibility
3. Long-term contracts	- simple and straightforward - avoids development and ownership risks - requires less staff - avoids involvement in BPA Tier 2 issues - stable rates - no capital investment needed	- limits resource diversity - no hedge against market risk - potentially higher cost than ownership options - load growth responsibility
4. Ownership/ Contract Portfolio	- provides resource diversity - possible transition tool - reduces capital requirements - portfolio approach dampens risks - avoids BPA Tier 2 issues	- diversity limited to the extent Tier 2 options not included - load growth responsibility
5. Ownership/ Contract/Tier 2 Portfolio	- most diverse option - involves PUD in Tier 2 cost issues and processes - most challenging from staff work perspective	- potentially more costly than contracting directly with suppliers, e.g. ENW

1. BPA Tier 2

The easiest option for the PUD to adopt, and the one many small utilities will likely choose, would be to turn to BPA for all future resource needs. The PUD would still be at liberty to contract with small distributed generation projects in the county, but primary responsibility for meeting load growth would be placed on BPA.

The potential cost of this option depends on how well BPA performs in procuring and managing new resources. BPA may acquire resources from others, but is prohibited by statute from building projects. It will look to Energy Northwest or others for new contracts and will fashion a menu of options for serving Tier 2 loads placed upon it. Because the existing federal hydro system will be dedicated to Tier 1 customers, BPA will have no special advantage over other providers in the marketplace.

2. Build or buy generating assets

In this option, the PUD would pursue equity ownership in new generating assets, most likely in partnership with others or through joint operating agencies. Ownership carries risk, but if development activities and operations are managed properly, ownership can provide stable power supplies at costs lower than the market can provide. The PUD would need to add staff under this strategy. More staff would be needed for projects where the PUD took a lead role.

3. Long-term power supply contracts

Rather than owning assets, the PUD could rely on a portfolio of power supply contracts to meet future load growth. Long-term contracts (from one to five years) are available from power marketers as well as from utilities with excess capacity. To manage risk, the PUD would procure a mix of contracts with different terms and attributes. In some cases, contracts could be tied to specific generating sources. The cost of this approach would depend on forward prices in the market at the time contracts were purchased.

4. Portfolio of asset ownership and long-term contracts

The PUD could follow a path that includes both contracts and asset ownership. In so doing, the PUD would gain the benefits offered by both strategies and reduce risk by increasing resource diversity. However, it is more complex than either strategy individually and carries with it some of the “cons” inherent in both.

5. Portfolio of asset ownership, long-term contracts and Tier 2 resources

The final option adds BPA Tier 2 to the power supply portfolio. Placing a portion of the PUD’s load growth on BPA would add resource diversity, but would necessarily involve staff in BPA procurement issues and policies. Unlike standard power purchase contracts where market and development risks are born by the seller, BPA contracts will need to include a mechanism for BPA to recover actual costs. As such, PUD staff would need to be actively involved in operational decisions associated with Tier 2 resources. And, it is likely that BPA will acquire Tier 2 power for pools of customers rather than individual customers. In that case, staff would need to pay close attention to the structure of the pool, the associated BPA rate process, and attendant risks.

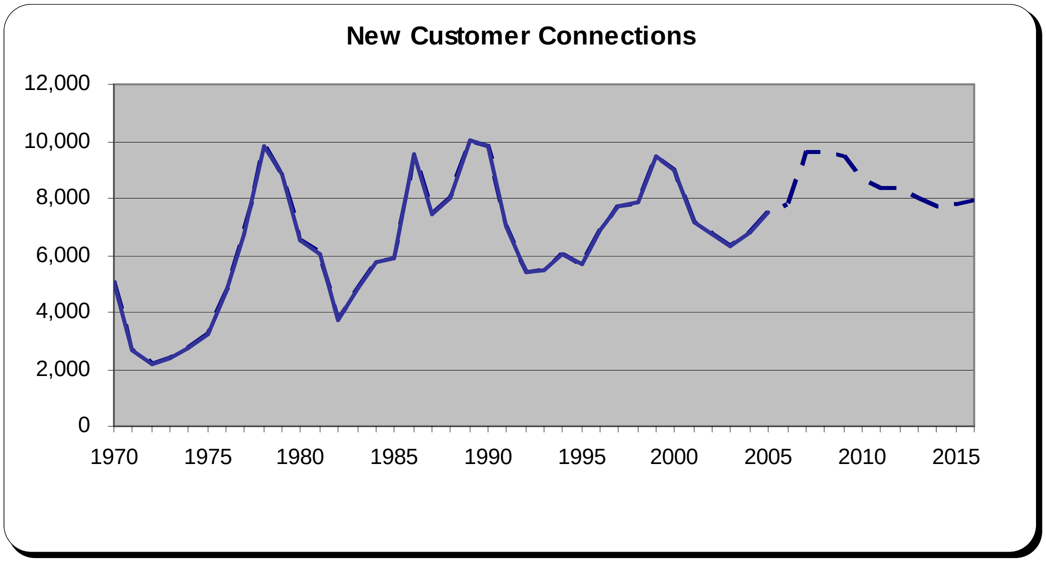
APPENDIX B

PUBLIC UTILITY PUD #1 OF SNOHOMISH COUNTY
2007 PRELIMINARY BASE CASE LOAD FORECAST ASSUMPTIONS

March 26, 2007

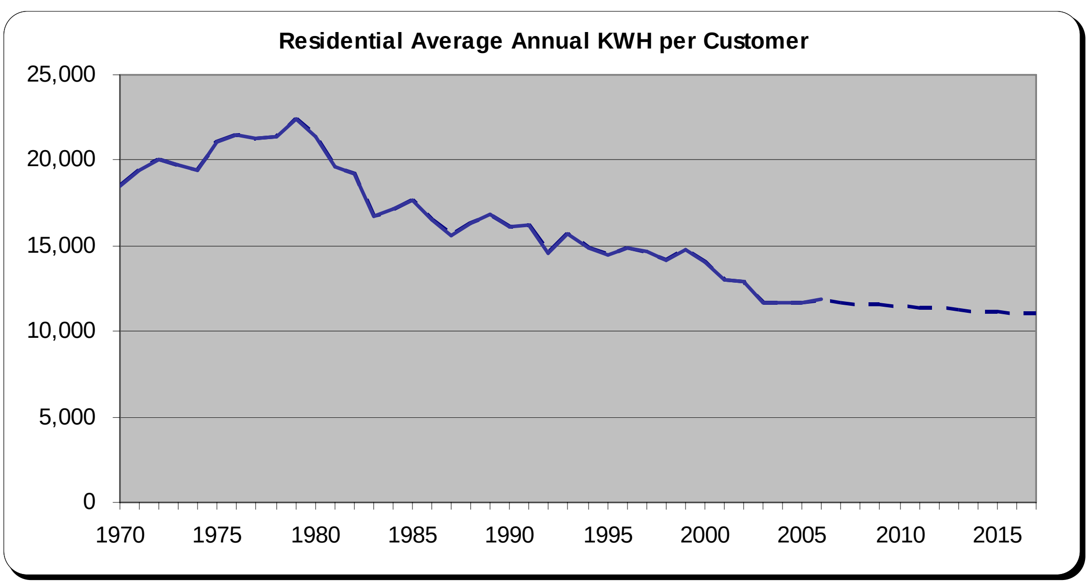
Prepared by Power, Rates, and Transmission Management Division

1. New Customer Connections



The new connect forecast is based on the Conway-Pedersen econometric model housing unit forecast and the historical relationship between commercial new connects and residential new connects. The housing unit forecast in turn is generated by the population forecast and demographic characteristics. Population is expected to increase from its current level of 670,000 people to 783,000 by 2013, and 866,000 by 2020. Family size is expected to continue its general slight downward trend. The forecast for total annual new customer connections over the next ten years ranges from 7,600 – 9,600 per year.

2. Residential End-Use Coefficients

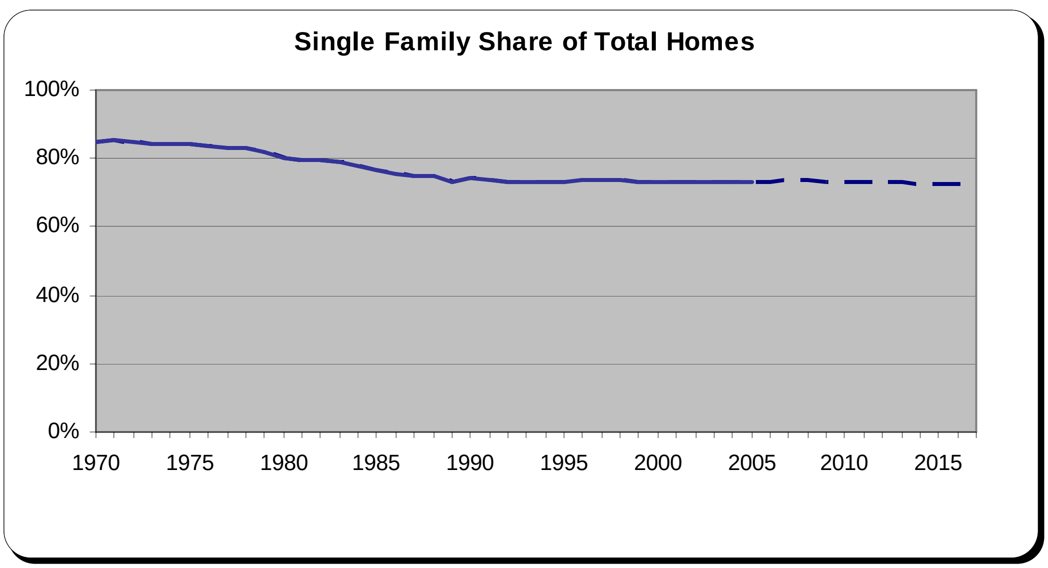


Residential average consumption has been falling for over twenty years. This has been largely due to conservation, fuel switching, and increased natural gas penetration. Average annual consumption per customer is now about 11,700 kWh per year.

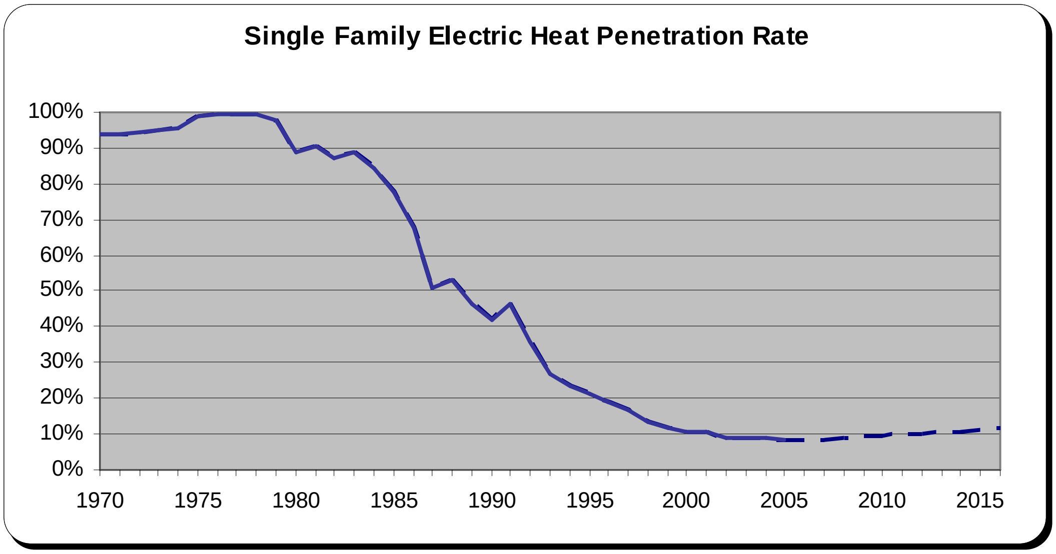
The existing housing stock was built under a variety of building codes and varying degrees of access to natural gas as a heat source. For new customers in the forecast we assume the following annual consumption values.

New Single Family Homes	KWH per year
Electric heat	15,138
Non-electric heat (Gas)	8,144
New Multi-Family Homes	
Electric heat	9,166
Non-electric heat (Gas)	5,628
New Mobile Homes	
Electric heat	14,484
Non-electric heat (Gas)	8,828

3. Housing Type and Heat Source



We are forecasting a slow decline in the share of new housing built for single family occupants.



The single family electric heat penetration rate depends upon natural gas distribution line growth and relative gas and electric prices. As shown in the chart above, the penetration rate has been falling for the last 20 years down to the current level of 8.4%. As natural gas prices have risen relative to electricity prices, and as more development occurs in the rural part of the county without gas lines, we expect the penetration rate to rise slightly.

We estimate that 750 existing single family electric homes will switch to gas each year. As with the single family electric penetration rate, fuel switching is based upon natural gas distribution line growth and relative gas and electric prices. We assume that additional fuel switching will occur largely due to natural gas distribution line growth.

We assume that 50% of all fuel switches will involve both space heat and water heater loads and the other 50% will switch space heat only. An average of 10,000 kWh per year will be saved for each fuel switch. This is based on 8,000 kWh for space heat and 12,000 kWh for switching both space and water heat.

4. Conservation

Annual Average MW Acquisitions

Residential	Commercial	Industrial	Total
1.8	2.8	1.6	6.2

5. Real Income Per Residential Customer / Income Elasticity

Nominal personal income is expected to grow at an annual rate of 6.5% over the next ten years, with real personal income growing at 3.8% annually. On a per customer basis, real income is expected to grow 1.4% per year.

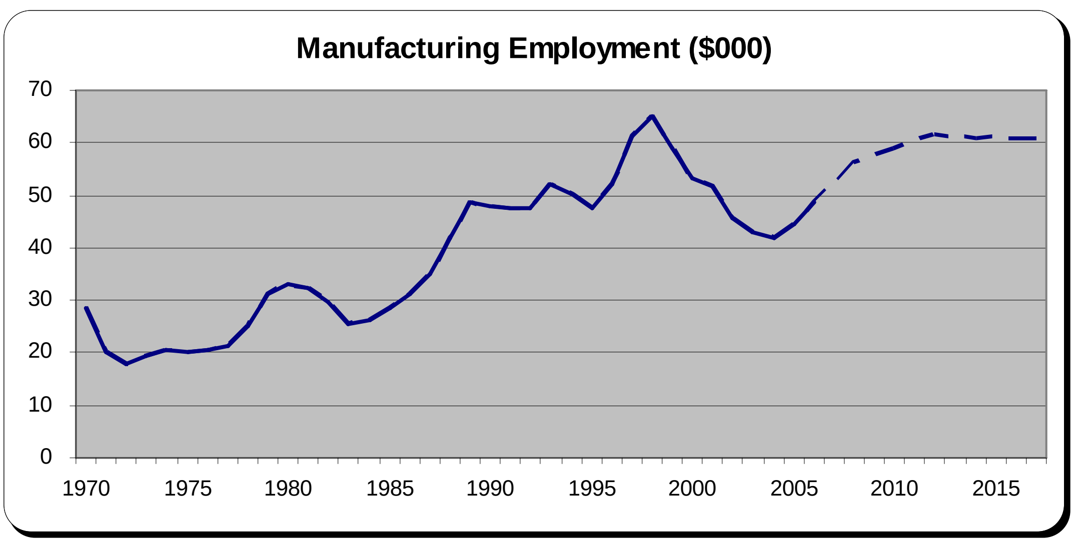
The latest econometric work we have done shows that the income elasticity of our residential customers is .31. Applied to a 1.4% average income growth rate this means that if everything else stayed the same, average annual kWh per residential customer would go up by 0.4% (=1.4% x .31). With an annual use per customer of 11,653 kWh, this means an increase of about 51 kWh per customer, other things remaining the same. This represents spending on household items as well as larger housing. Of course, other factors can act to bring use per customer down. These other factors include electric rate increases, natural gas rate decreases, conservation, fuel switching, falling electric heat penetration, and more efficient new homes.

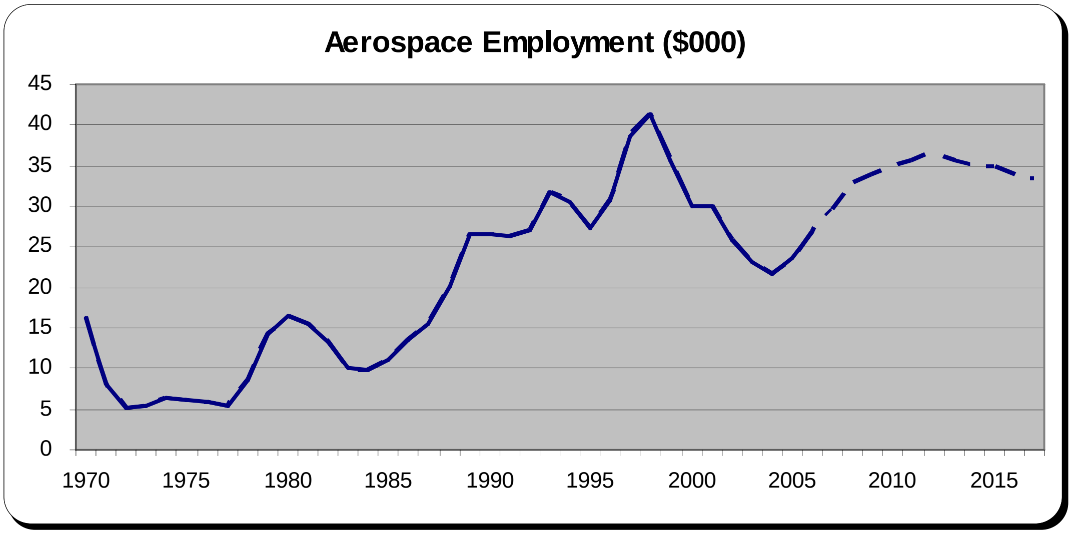
6. Price Elasticities of Demand

	Residential	Commercial	Industrial
Electric Elasticity	-.20	-.12	-.25
Gas Elasticity	.11	.11	.26

These elasticities are econometric estimates derived from annual models. They measure the response of customers to changes in real electric and natural gas rates.

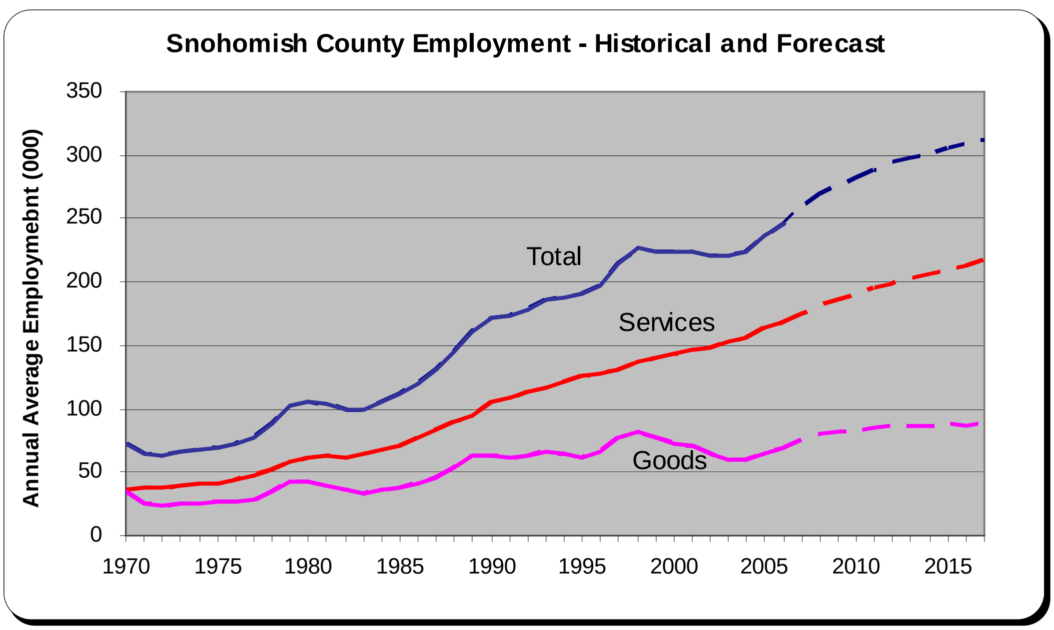
7. Industrial Employment





As the two charts above show, manufacturing employment is expected to increase over the next few years and then taper off and actually decline in the aerospace sector. The aerospace sector drives most of this with Boeing's production of the new 787 Dreamliner.

8. Employment Growth by Sector

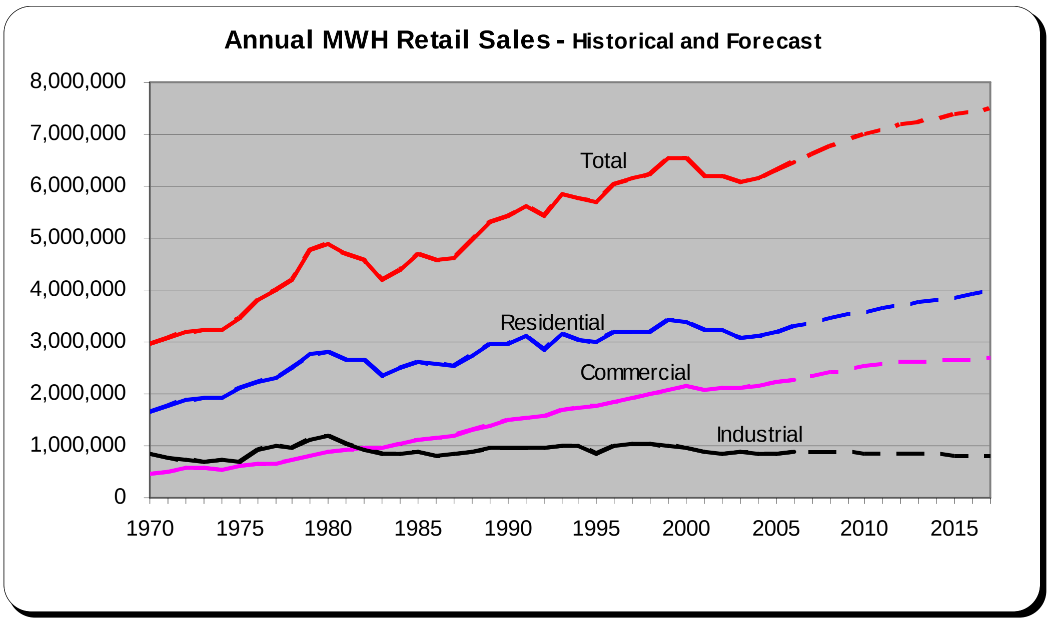


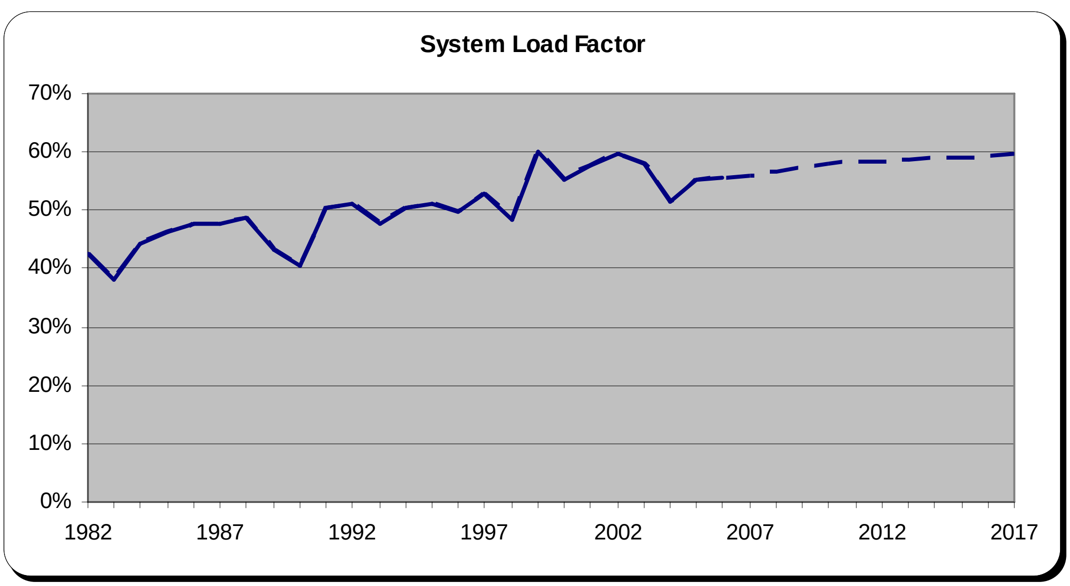
The Snohomish County Employment forecast is based on the Conway-Pedersen econometric model. Most of the employment growth is expected to occur in the service sector. Over the next ten years, we forecast 18,000 new jobs in the goods producing sector, and 49,000 new jobs in the services sector.

In the goods producing sector the biggest job gains are expected in aerospace and construction. In the service sector, the largest job gains are expected in retail and wholesale trade, finance, education and health services, and government.

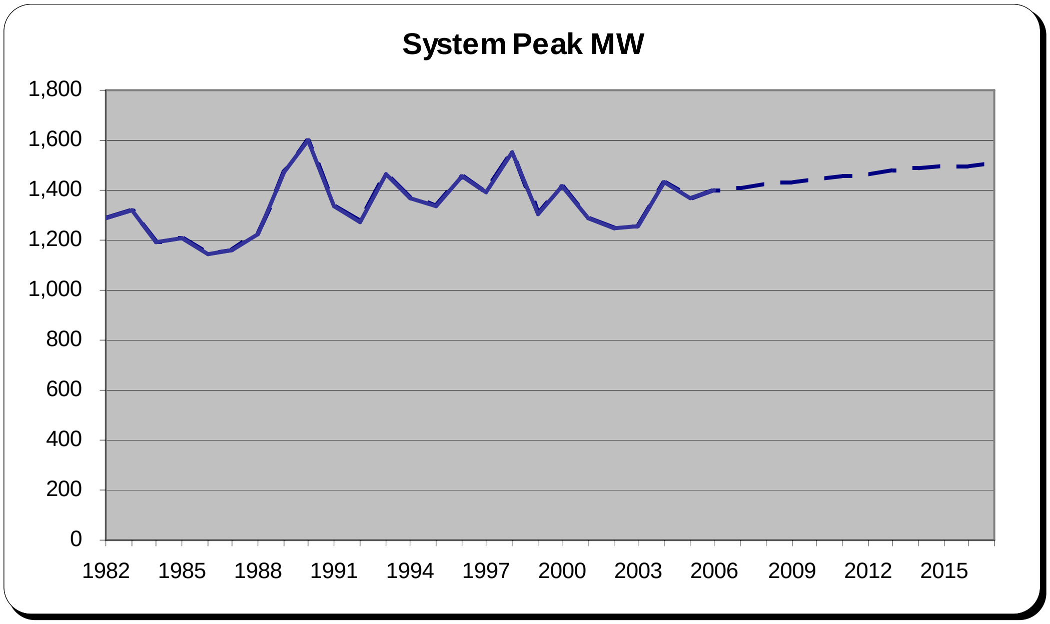
One of the key determinants of the demand for electricity by a commercial customer is the volume of business that they do. For all commercial customers we cannot easily observe this business volume but we can get data on a good proxy, namely the level of employment. We use the growth in employment, and its composition, in forecasting commercial demand for electricity.

9. Load Forecast



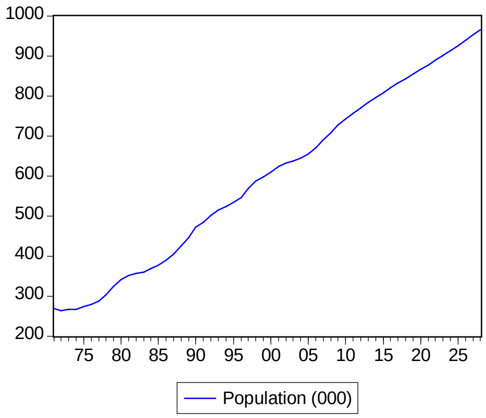


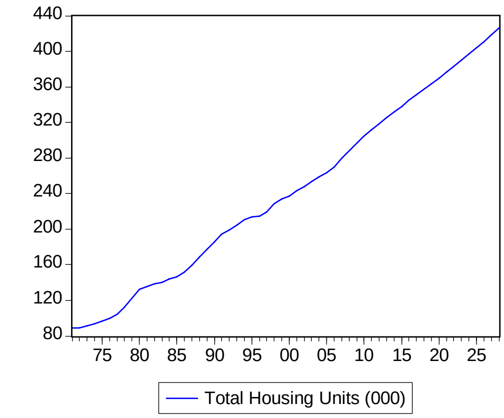
The system load factor is slowly rising over time. This is due to residential fuel switching, natural gas penetration, greater business operating hours, and other factors. These factors will continue which leads to a forecast for a gradually increasing system load factor.

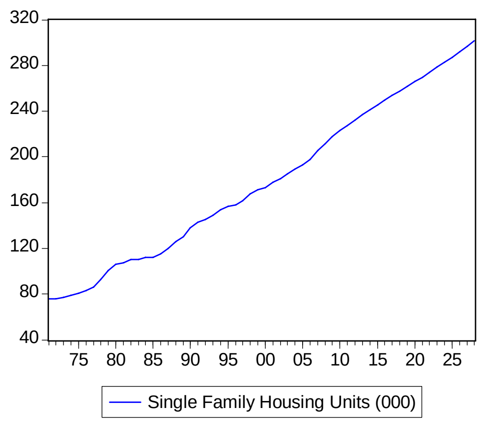


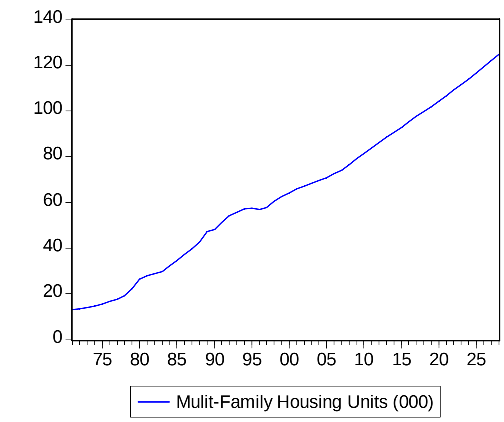
The next three pages contain the long-run forecast inputs for population, housing characteristics, family size, and employment by sector.

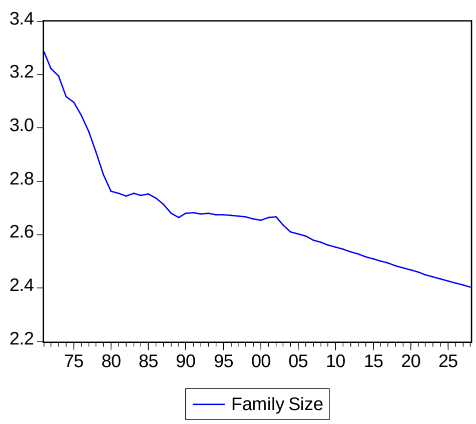
10. Long-Run Population and Demographic Forecasts

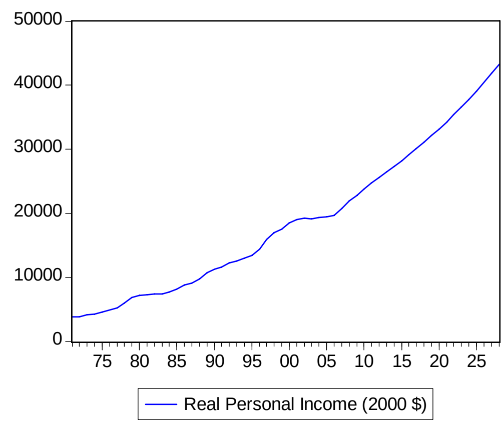




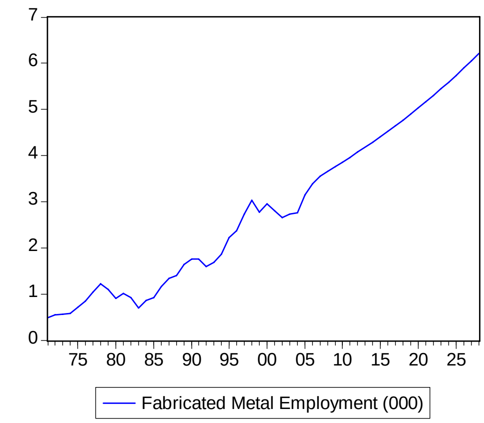


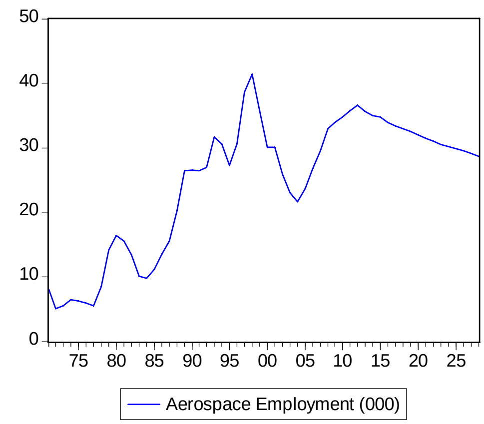




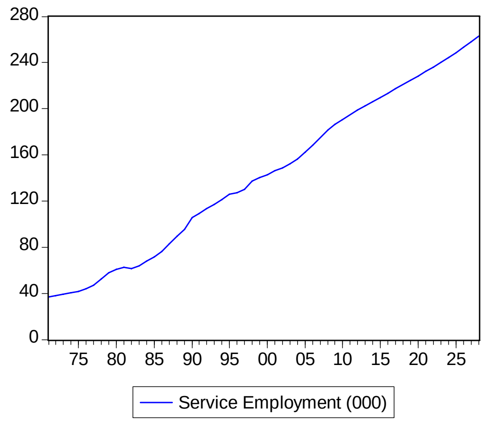


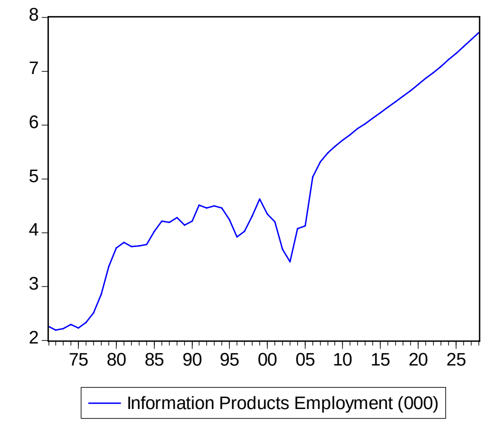
11. Long Run Goods Employment Forecasts

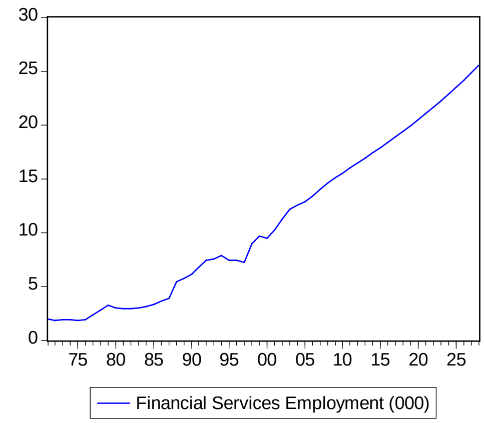


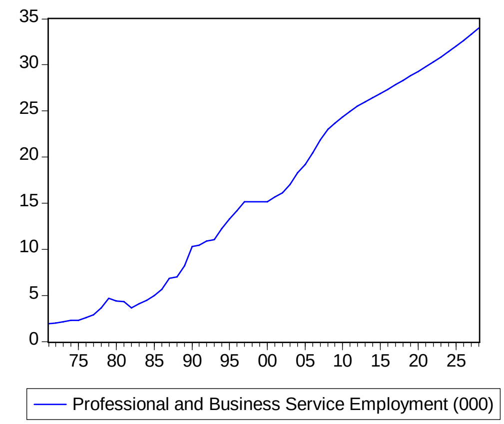


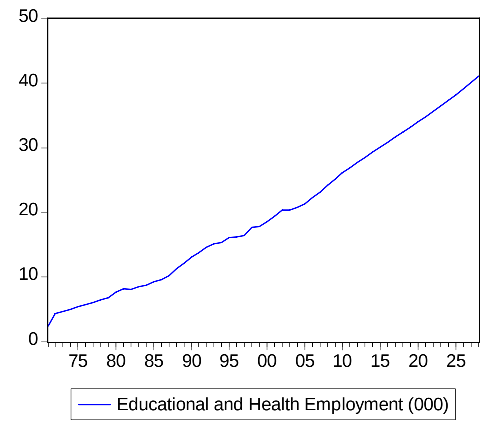
12. Long Run Service Employment Forecasts











APPENDIX C
DESCRIPTION OF SCENARIOS

"Wisdom begins in wonder." **Socrates**

The Art of Envisioning…

Planning for the future is not a simple task. Before we can determine which conservation measures and power options will best meet the PUD's needs, we must first consider the different ways the future might unfold.

We need to understand the dynamics of the world around us and how changes or events could impact PUD's operations. In forecasting natural gas prices for example, we recognize that we shouldn't just plot trend lines, but look instead at how people may be using natural gas in the future—what alternatives may arise, what inventions could transform its value, how conditions might affect its availability and so on. It is with this end in mind that we look beyond what is quantifiable and turn to the qualitative art of envisioning.

The Process…

PUD staff has prepared three 20-year scenarios that describe future realms of social, technical, legislative, environmental, and economic issues. Through a series of meetings, staff representing various interests of the PUD were brought together to brainstorm the future.

As each realm (environmental, technical, etc.) was discussed, the potential of its actually occurring over the next 20-years was pinpointed on a probabilities chart. Staff then assigned percentages to each event to represent the amount of either positive or negative impact the issue might have on the utility industry and the PUD.

Eighty-six realms of possibility and impact were plotted onto the probabilities chart. The most pressing issues were expanded to identify the *ripple effect* that could occur if these issues happened within the next two decades.

Variations on a Theme…

These issues and their related ripple effects were grouped into one of three scenarios. Each scenario was written from the 2027 point of view, looking backward.

"Growth and Consequences!" presents a future Snohomish Co. that over the 20-year time frame was privileged with a robust level of growth and prosperity.

"The Bleak House" centers on a future Snohomish Co. where *everything that could go wrong, did go wrong.* It discusses a world that presented the toughest possible challenges.

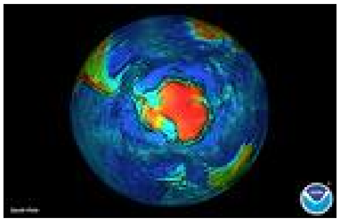
"Tech Goes Nano" explores a future Snohomish Co. where nano technology takes swift hold, allowing for the broadest range of unlimited revolutionary possibilities.

Each scenario is a story containing many possibilities—some of which could unfold, some of which may not. All of these possibilities, however, are based on ideas and technology in the minds of scientists today. As staff, we do not have a favorite scenario, nor do we purport to know just what will come to pass. But by thinking creatively and imagining beyond our current day to day experience, we hope to be able to position the PUD to meet any challenge the future might bring.

SCENARIO #1
GROWTH AND CONSEQUENCES

"Great things are not done by impulse, but by a series of small things brought together."
Vincent Van Gogh

Global Outlook



It is 2027. The U.S. is economically strong, supporting a low rate of inflation and unemployment. The country remains at the top of the superpower list, with China and India now running close behind. World trade has opened up a plethora of opportunities for many countries, creating a flatter global economy. The standard of living across the world is beginning to equalize, and the U.S. must work diligently to maintain its competitive edge.

As trade relations have emerged with a positive hue, so have political efforts as countries rely more on one another in a tightly interwoven global economy. Terrorism is no longer the threat it was at the turn of the century. The world as a whole has turned its hand against those who threaten security and safety by creating stronger world governing bodies to control wayward greed, terrorist tendencies, rogue leaders, and trade inequities. National stability has provided the economical fuel for the Puget Sound Basin and specifically Snohomish County.

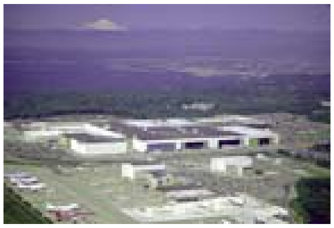
Puget Sound and Snohomish Co. Outlook

In 2006, Conway and Pedersen Economics, Inc. presented a 20-year Snohomish Co. Economic Forecast. The forecast was based on sustained U.S. expansion, strong foreign demand due to a weak dollar, above-average regional growth, along with geographical dispersion of growth, an aerospace industry production peak of 2013, and stable U.S. Navy employment. Twenty years later, we find that most of the foundational assumptions held firm.

Over the years, the aerospace industry turned toward outsourcing production and focusing primarily on computer-aided design and assembly. After 2013, efficiency gains in the industry caused a large decline in aerospace employment, yet it remained the largest employer in the county. Thousands were able to find new jobs created when new industries emerged and/or moved into the area.

The population steadily increased, bringing new opportunities and challenges to Snohomish Co. The major areas of growth came from the Port of Everett's waterfront redevelopment and expansion, the City's riverside development, and a new international airport at Paine Field.

Steady Growth



It is the port and riverside development that turned eyes toward Everett as it began to shed its unrefined industrial façade. The old Weyerhaeuser site was cleaned up, making way for scenic walkways, parks and a mix of high-end residential and small commercial venues. High clean-up costs, additional public services, increased rail and barge traffic, and new road construction costs were all offset by the benefit of more trade and property tax revenues. The Snohomish River area alongside I-5 was transformed from an industrial eyesore into several beautiful office complexes housing service-related and medical offices--upscale condominiums were perched overhead. The City of Lynnwood took great pains to continue the restructuring of its downtown core and popular upscale shopping mall. "Another Bellevue in the making" became its mantra. Outlying areas upgraded their sewer and water facilities, widened streets, and added parks and schools in order to accommodate thousands of new homes and commercial development.

After a long battle with local residents, Paine Field was declared Sea-Tac's "Little Sister Airport." It was designed to keep the area as livable and attractive as possible. Three leading hotel chains opened small properties adjacent to the airport, which also helped county tourism to grow. Due to the added noise level, several area companies chose to relocate to other parts of the county. Many of the vacant buildings became home to new server farms.

North of Everett, the Marysville/Tulalip area continued to develop and flourish, creating hundreds of jobs in the area. Department of Energy (DOE) funds for tribal renewables projects allowed a small wind farm, a methane facility, and two closed-circuit pumped hydro projects to be developed in Marysville. This not only helped solve local electricity transmission congestion problems during peak use periods, it brought much-needed renewable power into the area.

A new regional cancer treatment center located in Everett was followed closely by a host of research-related, medical services and pharmaceutical companies—making Everett a well respected medical hub. Single-cell medical research became a specialty in the region, and many of the very medical advances that came from that arena contributed to another set of challenges—people are living much longer.

People Thriving Longer

People living longer should be deemed positive; however, the stress on state and local social and medical services has taken its toll. A state income tax helped take up some of the slack in Washington state. Retirement savings were stretched 10 to 18 years beyond their original intent, leaving many with limited resources. Elder care and assisted living are a well-respected industry for those who can afford it—others must count on younger family members to set another plate at the dinner table and add more bedrooms. Many are now forced to work longer than the previously held 65-year mark. Area utilities offer more assistance programs for the elderly, especially heating utilities responsible for keeping the aged warm.

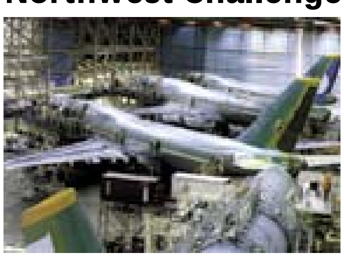
The large number of Baby Boomers entering retirement age has borne its own set of issues. Employment figures have dropped substantially as industry struggles to fill large holes in its talent pool. Winter migration respites to the warmer south now take a larger number of the aged from the Puget Sound area October through March. The number of active retirement communities centered around small homes, common activity centers and golf courses is growing significantly—this group of retirees does not sit still. Local political and charity groups benefit greatly from this generous community-oriented population segment.

Global Warming and I-937

Global warming became visibly apparent, and many people finally felt there was no choice but to adopt radical change. From suburban kindergarten classes up through the local and state governmental offices, citizens and corporations embraced climate change initiatives and product-packaging measures, energy efficiency, hybrid automobiles, tree-planting campaigns and more. In many states, the incandescent light bulb has been banned in favor of compact fluorescent bulbs (CFL) and LEDs.

Voters in Washington state voted in I-937, which mandated that all utilities meet 3% of their power portfolios with new renewable resources (not including traditional hydropower) by 2012, 9% by 2016 and 15% by year 2020. Utilities scrambled, seeking out and competing for the scarce renewable energy supplies and investing in small projects to satisfy the requirements. The market place responded with a new breed of resourceful small-scale power innovators; and a vibrant emissions cap and trade system was adopted and regulated. The Northwest region embraced wind power as its primary contribution but had difficulty getting the mandated amounts of electricity from Eastern Washington due to lack of transmission capability. Western utilities were able to pool resources on several projects, including tidal energy, biomass, offshore wind, manure and landfill, geothermal, and a handful of co-generation projects. Snohomish County capitalized on stand-alone solar plants using incredibly efficient antireflection nano-coated solar cells, which decrease light reflection in order to produce more energy. They were able to double the amount of solar output typically produced in overcast zones.

Northwest Challenged



Integrating new, more expensive and intermittent renewables into the grid added costs for the entire region. The government and the public had underestimated not only the price discrepancy between hydro and these pricier forms of generation--but also the price of expensive transmission upgrades necessary to transport it. Overall, regional electric rates were driven up over 50%.

Electric customers have responded to the higher energy prices by purchasing smarter appliances and adopting cost-effective heating and efficiency upgrades. Better integrated design practices have been adopted by residential and commercial interests. The entertainment-hungry residential sector gobbles up large quantities of each new innovation—large flat-screen monitors and televisions; game and home theater systems; surround sound; and “smart home” automated lighting, security and heating/cooling systems. Energy technology has adapted to create efficiencies; however, people continue to install more and more into each room of their homes. As a result, federal and state legislation has forced stronger efficiency and sustainability practices on builders and developers.

People, Technology and Innovation

People and industry have adopted a more carbon neutral lifestyle. And while people are not inclined to give up their personal household luxuries, they are willing to work as a group to protect their air, soil, water, and other irreplaceable natural resources. They have sought out products with less packaging, and use cleaner burning fuels in their cars. They compost, take part in green power programs, and plant trees. Global warming has been positively affected by worldwide cleanup efforts, moderating the steep catastrophic trend line.

As people adapted to an earth-saving lifestyle, they replaced their worn vehicles with an array of attractive, energy-efficient, and non-polluting vehicles. Biofuel has become a fuel of choice, and there continues to be an abundant supply from U.S. farms and from Brazil. Hybrids, electric cars and plug-in hybrids have become extremely popular as a way to contribute individual solutions to the air problem. Due to a sizable plug-in hybrid tax credit, along with aftermarket conversion kits for previous versions of standard hybrids, a sizeable number of vehicles are now plug-ins. Over time, the nationwide electric industry has been able to convince plug-in owners to recharge during off-peak hours.

The plug-in vehicle trend coupled with the design of light-weight, nearly-indestructible composite materials, has produced smaller, safer automobiles built for single passengers. Smaller lanes for these vehicles have been added to overburdened freeway systems in the Northwest to alleviate traffic congestion. The state also mandates that any company with more than 300 employees must designate one-quarter to either flexible or telecommuting schedules. Mass transit is still inconvenient for many.

Nuclear Power

Despite the emphasis on the environment, conservation and renewable resources, the expanding economy demanded the addition of more energy. Those too young to remember Three-Mile Island (1979), Chernobyl, and Tokai-mura became a stronger voice for nuclear power world-wide. With billions in federal incentives available, they became the investors, scientists, politicians, and public who backed a powerful resurgence of nuclear power. Nuclear energy became safer and more efficient with the advent of nano-technologic fuel and nano-fluids. Several pilot projects for nano-deconstruction of nuclear waste were proved highly successful. Two new reactors were sited in the Northwest region, one in Idaho and one in Washington. The much-needed energy was integrated into the power portfolios of regional electric companies.

Deregulation

The Federal Energy Regulatory Commission (FERC), promoted primarily by private industry, continued to flirt periodically with nationwide mandatory deregulation. These efforts were strongly opposed by utilities and consumers on the West Coast who had weathered the energy crisis in 2000/2001. When FERC was unable to convince all regions of the nation to form Regional Transmission Organizations (RTO), the Northwest created the Columbia Grid (CG). CG had the major challenge of determining how much-needed, new reliable transmission would be built and funded in the Northwest region. It is now one of the strongest, most well coordinated grids in the country; able to enhance reliability through foresight and an efficient new scheduling system. In turn, new sources of renewable energy become available due to expansion of the transmission system.

Competing Interests & Oversight

After 20-years, the Northwest region continues to argue the value of removing the four Snake River Dams that environmentalists, tribes and outdoor enthusiasts say is necessary to save the salmon. All stakeholder groups continue to push their agendas and reframe science and statistics to fit their cause. It is this very confusion, along with a huge backlash from electric ratepayers that has allowed the dams to stand.

California's growth and bottomless energy needs continue to concern power producers from the Northwest. Transmission congestion issues were worked out between several states and Canada to accommodate California's summer power needs. California became aggressive in its pursuit of renewable energy and natural gas. There were concerns that California would take more than its fair share of Northwest and Canadian energy supplies. But all West Coast energy utilities were helped when the high-voltage direct current (HVDC) Northern Lights Canadian transmission project was completed. The project now adds about 1500 MW of electricity generation to the region at a competitive price.

Another concern the Northwest faced revolved around repeated attempts by the federal government to privatize BPA. Rumors still circulate yearly that perhaps Washington, D.C., would choose to spread the benefit to other regions of the country.

Natural Gas & Oil Concerns

Natural gas and oil issues have magnified over the past 20 years. As China grew it took large amounts of the world's oil and liquefied natural gas (LNG) supply with it. Despite the emphasis on clean energy, western states became increasingly dependent on natural-gas-fired turbines for electricity generation. When Northwest hydroelectric power diminished due to salmon concerns, low-flow water years, irrigation, recreation and barging issues, natural gas further dominated the market price of electricity. Price volatility and availability have become an increasing cause of concern. The bulk of natural gas supplied to the western states comes from British Columbia and Alberta, and the Rockies. Lately more supply is coming in through several new western LNG terminals. Supply and price volatility of natural gas is more common because eastern U.S. markets have gained increased access to supply, and Canada's own growth and consumption have limited its U.S. exports over the years.

We Still Stand Strong

All in all, Washington state and Snohomish County have faired well over the past 20 years, and both look to the economic future with positive anticipation. Growth has been strong but with the foresight of many capable leaders, it has been channeled into the most efficient and beneficial paths for the region. What will the next 20 years bring? Only time will tell.

SCENARIO #2
THE BLEAK HOUSE

"Success consists of going from failure to failure without loss of enthusiasm." **Winston Churchill**

National Outlook

It is 2027 and the U.S. economy is fairly stable but with moderate inflation and unemployment. Consumer confidence has not been strong over the past decade and has left most with fear of more economic turbulence ahead. The expense of a 12-year military effort in Iraq--followed by five years of clean-up efforts and skirmishes with other Middle Eastern countries—took an incredible financial toll. Funds diverted to the military efforts left sizeable holes in necessary federal programs. The follow-up war on terrorism created its own black hole for funds used to hunt down small extremist groups around the globe. Terrorism was driven further underground--attacks were smaller, more random and very frightening for citizens in many countries.

The unprecedented growth of China and India hindered several major U.S. industries. The flattening of global markets created trade opportunities for more countries and, in so doing, managed to deflate U.S. market share. Industries on American soil found themselves scrambling to maintain their U.S. customers as fast-paced, global Internet purchasing became the norm. A high standard of living among Americans is no longer assumed.

Northwest Outlook

In the Northwest region, the economic outlook is bleaker than elsewhere with higher-than-average regional inflation and unemployment rates. Through a series of unfortunate events over the past twenty years, historically low electricity prices in the Northwest were forced higher, causing economic stagnation throughout the region. Snohomish County was hit particularly hard due to its reliance on Boeing and once low Bonneville Power Administration (BPA) prices.

After decades of contrasting reports and arguments about salmon restoration among various stakeholders, in 2013, it was determined that the four lower Snake River Dams should be removed. BPA had estimated in 2007 that breaching of the dams could cost Northwest electricity ratepayers up to $550 million a year for replacement power, but by 2015 the costs had soared much higher. BPA was forced to purchase additional power at volatile market prices to make up the supply difference, leaving the actual costs to the region at just under $725 million per year. Regional utilities had to sign into 20-year BPA contracts at its higher Tier 2 rate because BPA had a shortage of hydropower to offer within its less expensive, cost-based Tier 1 rate. Natural gas prices rose as well due to foreign competition.

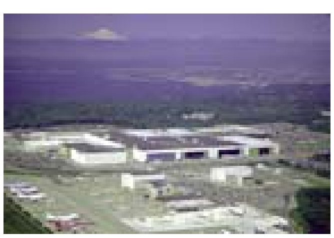
Air quality impacts were felt throughout the West as more thermal generation was needed to cover the loss of clean hydropower. Agricultural food prices doubled as area farmers dealt with the lack of irrigation water or lost their fields altogether, which drove many of the large grocery store chains to purchase products from California and Oregon. The Northwest was losing its competitive edge.

Utilities responded to I-937 by relying on localized renewables projects such as methane, landfill, tidal, co-generation, off-shore and small-scale wind, and closed-circuit pumped hydro. Some of these projects have been developed individually and some by a consortium of Puget Sound utilities. Utilities faced stiff penalties if the requirements were not filled--something had to give. Rates across the Northwest region rose dramatically. The animosity that rate increases created among ratepayers made new generation and transmission siting tough as people lashed out against the perceived overpriced power companies.

Competing Issues

Growth in California has been strong. Power not being utilized by Pacific Northwest business has been quickly absorbed southbound. Washington state's decades old battle with BPA over Canadian entitlements, rate strategies, salmon issues, and budgetary transparency took considerable efforts. While the Northwest was distracted battling its issues and economic decline, California quietly tied up long-term contracts for wind power and natural gas from Canada. California's demands for a permanent piece of the Northwest's federal power privileges paid off when the Federal Energy Regulatory Commission (FERC), with the support of the Department of Energy (DOE) and the U.S. Congress, directed a portion of BPA power be sent down to meet the power requirements of the state of California. Power supply choices dwindled in the Northwest. And when it became clear the economic downturn would last for quite some time, possible nuclear investments disappeared.

Snohomish County & Everett Cope



After Weyerhaeuser and Georgia Pacific moved to the southeast U.S., Everett's major paper company announced that it too would relocate. Snohomish County immediately felt the pain when it closed its plant. Boeing, already impacted by higher steel costs and China's decision to build its own passenger airliner jets, cut production and moved a portion of its assembly to Eastern Washington where tax incentives were offered and power prices were more favorable. Boeing's move resulted in thousands of layoffs in the Everett area. Power intensive companies that had been eyeing the Pacific Northwest as a potential home went in search of better power rates and business climate. The U.S. Navy population base in the area has managed to hold steady.

Plans for renovating and expanding the Everett Port area were mid-stream when economic turmoil caught developers off-guard. Banks were left with hundreds of overpriced waterfront condominiums, and the City of Everett was overextended due to the high clean-up costs of toxic areas. The concept of expanding Paine Field into an international airport was placed on hold, as well as a much needed regional four-year university. A major cancer center was successfully added to downtown Everett in 2012 and took up some of the unemployment slack. It also brought with it a number of smaller support companies, mostly research- and supply-related.

The effect on the people of Snohomish County was unsettling. Housing prices dropped drastically, leaving those who had trusted in their equity for retirement savings with nothing. The high unemployment rate began its slow domino effect throughout the economy. The poor economic outlook was joined by fear when reports of Yellowstone's impending explosion were exaggerated by the media. Mt. St. Helens and Mt. Rainier were volatile as well--outlook was grim. People held tightly to their purses and any fortunes they had left. Concern over rampant lack of privacy and identity theft further weakened trust in the economic system.

Smaller business that once served a thriving area closed their doors or relocated. An area that once took pride in its diverse ethnic nature grew tense when competition for employment began to heat up. Flex-time, bus passes and telecommuting were halted as larger companies tightened the reigns of productivity and cost efficiency, which only increased traffic congestion and reduced air quality. Innovations designed to reduce travel-related CO2 emissions (plug-in and standard hybrids, electric and single-occupancy cars, biofuel driven) were only affordable to the declining numbers of the well-employed or as part of federally supported fleets.

Global Warming

Earnest efforts at the turn of the century to confront the world on global warming issues were met with mixed reviews. While scientists had documented clear evidence of warming, industry and political forces continued to dampen the message. The coalition of Western states chose to back an immediate reversal of harmful carbon dioxide and heat-trapping gases, yet the U.S., several developing countries and the oil industry were not as quick to alter course. As early as 1990, the U.N.-sponsored Intergovernmental Panel on Climate Change warned that greenhouse gases would alter the planet's climate in dangerous ways, but the aggregate tipping point started much earlier than predicted.

The most obvious signs became visible in the Arctic--as rising temperatures melted ice, reshaped landscapes and altered the lives of native wildlife. Spring now comes much earlier and we experience more extreme heat and drought, warmer oceans, rising sea levels, and higher intensity tropical storms than ever before.

The Northwest has its share of the global warming blues. Higher ocean temperatures now bring southern native fish such as mahi mahi, barracuda, striped bass, and even marlin into Pacific waters to join the dwindling salmon and cod populations. The marine food web chain has been altered, and some southern additions such as hake and mackerel, are now avid predators of baby salmon. Salmon runs that were stressed for decades now face streams where gravel and salmon eggs have been washed away by added rainfall, and in summer the streams are slower flowing and so warm that they kill the salmon. Birds and land animals have also migrated up from the south.

As the Earth has warmed over decades, the sea levels rise slightly each year. Glaciers have melted into the water system--including 12 of 117 Cascade region glaciers that disappeared completely. More than four inches of coastline worldwide have been altered. The state capital of Olympia was forced to employ a system of dikes and pumps to keep the city stable.

Shorelines from Everett to Mukilteo and other low-lying coastal cities have lost buildings and housing built on stilts or weakened bluffs--claimed by closer rising tides. Sewage lines have been impacted as well. Snow levels have risen at the rate of 300 feet for every degree of warming, shortening the winter ski seasons from four to 2.5 months. Northwest rivers, swollen with excessive melt-off and higher levels of rainfall, regularly flood riverbank inhabitants in the winter months.

In the summer, declining water supplies are causing several innovative water utilities to pump water from winter runoff into underground storage units for later summer use. Since winters are warmer, electric utilities have adjusted to a lesser load. Forest fires are now wild and prevalent, taking their toll on the pristine Northwest wilderness. Heat, fire and drought combine to foster stronger insect populations, with fewer cold winters to stop the spread. One positive for farmers not impacted by irrigation loss due to the removal of the dams is the longer growing seasons. Wind patterns changed and have actually improved the consistency of output for wind turbine projects.

Conscientious Change

The sudden onset of and severity of global warming caught some unprepared but the conscientious are ready to face the challenge. Concerned about the future of their planet, they now purchase online carbon offsets for $25 per ton. Most individuals are able to erase their carbon footprints for around $300 per year. They also pay carbon neutral fees for products, packaging, travel, grocery bags, and more.

Faced with global warming, loss of jobs, businesses and homes, high energy rates, volcanoes and high housing prices, people have pulled together. Snohomish Co. has taken hit after hit but in 2027, it is still standing. Times will get better. It has been 20-years in "the bleak house." What could go wrong *did* go wrong. Those who could suffer *did* suffer. Those who could help *would* help.

SCENARIO #3
TECH GOES NANO

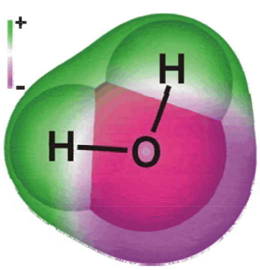
"The creation of a thousand forests is in one acorn." **Ralph Waldo Emerson**

Father of Nanotechnology

The old axiom that "knowledge and technology double each year" is an understatement! It is 2027, and looking back over the last 20 years is like stepping onto a fast-moving roller coaster of technological change.

It was in 1959 that Nobel Prize-wining physicist Richard Feynman introduced the concept. He was convinced that a set of conventional-sized robot arms could make a duplicate of itself at 1/10th the original size—and that one could in turn make another set smaller, until a molecular scale is reached. He believed those tiny molecular tools could then be programmed to build in a form known as "bottom-up manufacturing." Instead of cutting away material (top-down manufacturing), you would actually program these tiny robots to build what you needed. Nanotechnology is now known as *any* application of science and engineering at the atomic scale.

Limitless Possibilities



We suspected in the early 2000s that full-scale molecular nanotechnology would produce results, profits and worth sometime between 2010 and 2025. Timing was dead-on. Molecular nanotechnology has revolutionized vast arrays of human activity: materials manufacturing, energy, security, healthcare, scientific research, communication, computing, warfare, and more. It was akin to the advent of electricity, transistors and the Internet. Once one application was introduced and proliferated, hundreds of other uses were quickly realized. It has impacted every industry around the globe. By 2014, the annual global market for products that apply nanotechnology exceeded $2 trillion and employed over two million workers worldwide.

U.S. Takes the Lead

The U.S. has surpassed Europe and China as the world leader in nanotechnology, taking large part in the innovation and world-wide legislation needed to contain any negative effects of the molecular science. Finding that much of the robotics software industry that Microsoft had pioneered (2000 to 2010) would dovetail nicely with many nano-tech applications, Bill Gates invested finances and the human capital necessary to put Washington state at the top of the nano-game.

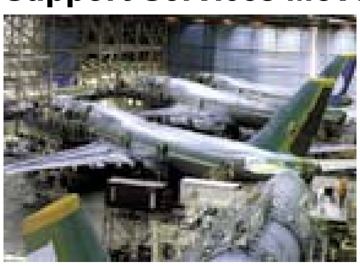
Snohomish County goes Nano

Just as Bellevue and Redmond were transformed by the explosion of Microsoft's original OS success, Snohomish County has borne the fruits of *this* technological revolution. The population of Snohomish County doubled from 2007 to 2027 as more people have been drawn to the Puget Sound region to participate in this burgeoning industry. The Everett Port expansion has allowed upscale multi-family housing units that satisfy housing needs. Small shops, coffee-Internet houses, parks, ethnic restaurants, and micro breweries are interwoven into the fabric of waterfront residential living. The Snohomish Co. International Airport (Paine Field) now serves the ranks of new traveling corporate executives. Eight leading hotel chains dot the area. Boeing is a leader integrating the new manufacturing techniques into its fleet design and production.

Major breakthroughs have been made in the fields of thermoelectrics, radiation transport, microfabrication, and security and environmental sensors. In the case of the environment, sensors detect harmful contaminates in the air, water and soil. The same sensors dispatch tiny nanoparticles to eradicate the offensive intruders—all within seconds of the actual detection. Security sensors insure the detection and eradication of such terrorism acts as bombs, water and food tampering, and toxic air poisons.

Biomedical and bio-science fields employ nearly limitless uses of nanoparticles. Bone can be repaired almost instantaneously, blood can be quickly cleared of harmful cholesterols and radicals; and cancer has just about been irradiated due to nanoparticles that can burrow into a tumor, seal the exits and detonate a lethal dose of anti-cancer toxins, all while leaving healthy cells unscathed. A major cancer treatment and research center in downtown Everett has brought with it a host of medical support businesses.

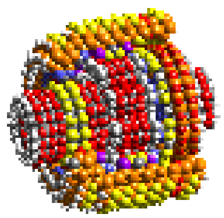
Support Services Move In



Environmental responsibility has become an industry unto itself as fast-paced regulatory changes keep up with impacts of nano-technology. Product lifecycles and environmental impacts are closely monitored. Several new employers in the Everett area serve this niche. Nanocomposites have completely changed the way aircraft, automobiles, plastics, and building materials are produced, allowing for stronger, lighter, rust-proof components. High-school tech programs train thousands of workers into several new composite-driven companies. Many industries and government agencies benefit from Snohomish Co. composite companies.

All new commercial growth within Snohomish Co. comes under strict pollution and carbon emissions guidelines. The area has worked hard to clean up the Puget Sound's water and air. Strict standards have evolved since Washington state embraced the 2007 Washington State Climate Change Challenge and rules governing energy production.

Nano-Fueled Renewables

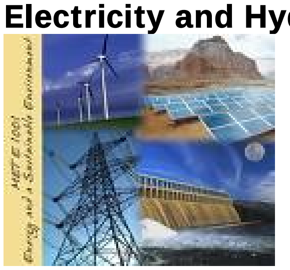


Nanodots and nanorods have revolutionized the solar field. Fabricating quantum dot photovoltaics--using a microcontact printing process—is far more efficient than the silicon used in previous years. Other areas impacted by nanotechnology are nanowire-based, dye-sensitized solar cells, heat transfer enhancement in nanofluids, hydrogen storage, and electrochemical conversion and storage. Nanodigesters are also used in waste management so that landfills and cow manure can produce methane much quicker for electric generation.

Nuclear energy becomes safer and more efficient because nanotechs change the shape of nuclear fuel from solid cylinders to hollow tubes (the added surface area allows water to flow inside and outside the pellets, increasing the heat transfer). Technology boosted the cooling capability of ordinary water by using nanofluids (water interspersed with tiny particles of oxides and metals just billionths of a meter in diameter) to remove up to two times more heat than ordinary water.

Fuel cells are being mass produced, thanks to nanotechnology that taps efficient, inexpensive catalysts for hydrogen production and storage.

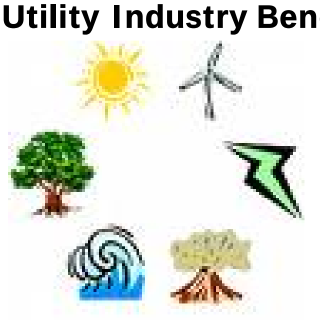
Electricity and Hydricity



Over the past 20 years, annual energy use in the U.S. has grown to 134 megajoules—one fourth greater than in 2005—creating the need to transport over 400 gigawatts more power. Realizing the need to reinvent the U.S. electrical system *and* to accommodate hydrogen distribution, the Continental SuperGrid was formed. For decades scientists worked on developing super cables that could transport energy in both electrical and chemical form. They succeeded and built the system alongside the existing grid one leg at a time, until it covered the entire nation.

The supercables house two conduits (1 meter in diameter). The inner conduit carries resistance-free electricity through a superconducting material that is surrounded by a second conduit filled with ultracold hydrogen (liquid or supercritical gas). The cryogenic cooling hydrogen keeps the resistance down and transports the secondary fuel source to households that thrive on fuel-cells, and to hydro-stations that distribute for fuel-cell transportation. The SuperGrid allows easy integration and transmission of intermittent forms of renewable energy from outlying areas.

Utility Industry Benefits



Local electric companies have taken advantage of polymeric nanocomposites (artificial substances inspired by spider silk that are both stretchy and strong) that nanotechnologists have developed, reinforcing solutions of a commercial polyurethane elastomer (a rubbery substance) with nanosized clay platelets to produce a more resilient overhead line casing. The lines withstand higher temperatures and can flex with the wind and heavy ice or snow—so surrounding vegetation cannot snap lines. It has been the perfect solution for electricity distribution beyond the SuperGrid to homes and businesses. The initial replacement cost for utilities has been steep, but lower maintenance costs provide a quick pay-back.

As the public has demanded more and more distribution lines be placed underground, utilities are employing tiny three-inch-tall robots to roll along underground power or water lines to diagnose troubles. This greatly reduces high costs associated with undergrounding cables. The robots carry a thermal sensor to locate hot spots, an acoustic sensor to listen for the crackle of sparks, and a dielectric sensor to detect moisture. Utilities also use smart grid technologies to give them real-time visibility into their end-to-end electric distribution networks. Every meter and transformer and point in between is an information source to feed performance data back to the utility. It provides the tools utilities need to implement real-time, self-monitoring networks, greatly reducing detection and down time.

Transportation & Traffic

The nano/hydrogen revolution has produced an "electrolzer" that uses electricity to extract hydrogen from water, and a "thermal cracker" that uses heat from nuclear power plants for hydrogen extraction. The resource is now as readily available as water. This enables the auto industry to adapt to fuel-cell technology, because the fuel is readily available and price efficient. Hydrogen infrastructure issues have been addressed by venture capitalists who have built hydro stations ahead of the oil and gas companies, locking up hydro-rights and market share. Exxon, Chevron, Conoco, and Shell have taken huge losses as they were left to serve the remaining internal combustion vehicles, outdated lawnmowers and a portion of fuel-cell hybrid cars.

Plug-in hybrids and all-electric vehicles are now considered old-style and inefficient, replaced by hydrogen hybrids that house a hydrogen and a gasoline tank. Another breed of hydrogen auto uses an onboard fuel cell to turn hydrogen back into electricity by combining it with oxygen. The new automobiles boast 60% to 65% fuel efficiency.

While the new breed of automobiles creates cleaner air and better fuel efficiency, it doesn't cut down on the number of cars per family. However, traffic has been greatly reduced because many companies have downscaled and eliminated corporate offices. A new system of levitational supertrains also has helped alleviate the traffic congestion. The rails now closely follow the I-5 corridor, built directly over and beside the existing freeway system.

A Whole New Breed of Techie

The city of Everett was in a prime position for an infusion of young, highly trained nanotechs. The best and brightest from universities worldwide have been recruited by new local nanofirms and paid well for their high-priced educations. Housing prices have skyrocketed as has the standard of living for most in the area. The less educated flounder as jobs become progressively more technical in nature.

This new breed of Everett resident has brought with it a fast-paced and varied lifestyle. High tech through and through, they are wired from head to toe with entertainment, communication, electronic schedules, and blazing-fast Internet connections. Everett techies can work from where they stand at any moment—no office cubicles are necessary. Their sneakers are even embedded with nanogenerators so they have an endless supply of energy for the gadgets they carry with them throughout the day. Most companies adopt a “work from home, street or Starbucks” mentality. And due to worldwide business operations, they are connected 24-hours a day to cover every possible time zone. Telecommuting, electrocommuting, flex hours, and a relentless information-induced pace drives this generation. Classes are filling up on how to “unmerge your job & personal life.” Where most employees are willing to be on-the-job at any hour, we are beginning to see a backlash and a call for corporate distance when in “family-mode.”

Techies embrace a constant realm of entertainment, often loading each room in their home with high-end plasma computer screens, wall and counter multi-touch display screens, interactive white boards, televisions, automated comfort systems, and frequency-canceling sound systems that only they can hear. Energy vampires have been slain. Handheld cell phones with added text/camera/GPS/video/Internet/calendar/address book combinations boggle the minds of older Baby Boomers. This new generation of techies does not fear Internet security the way older generations do. They know all information is accessible to anyone at any time. Computers are registered and locations tracked by GPS. Identify-theft detection and initiation tracking is lightning fast; people rarely get away with it. And those who do are punished harshly.

Opportunities in Education

Washington’s shortage of quality four-year universities was solved by our thriving new college north of Everett. From the beginning, its “Green MBA” and nano technologies program have drawn strong ranks of savvy students from across the nation. This influx added burden and opportunity to Marysville’s decade-long growth pattern. Hundreds of smaller, affordable multi-family housing units have been developed, many of which are combined with small retail and service venues, centered around small park-like settings. Students thrive on jobs made possible by the Tulalip Tribes, working at area casinos, specialty shopping malls, theatres, restaurants, and hotels.

Simpler Times

The world will never be the same again, and we cannot go back to simpler times. We are instead left to embrace, or at least adjust to, nano-revolution. The people of Snohomish County can say they were there when the world changed.

THE IMPLICATIONS…

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."
Charles Darwin

Each of the above scenarios is hypothetical but visionary in scope. Embedded into each scenario are hints and elements of truth with which the PUD may actually have to contend. Staff within the PUD went through each scenario to pull out elements that could be tagged as a quantifiable impact. This allows flexibility to be built into the IRP based on what *any* future may bring. It allows us to be responsive to change.

Selected Implications of Scenarios

Snohomish Co. PUD Relative to Base Case	**Scenario #1** **Growth & Consequences**	**Scenario #2** **The Bleak House**	**Scenario #3** **Tech Goes Nano**
Load Growth	Significant load growth over Base Case Expanded Plug-In Hybrid Load	Lower load growth than Base Case	Load growth variable -- equal to or reduced compared to Base Case
Implications for Resource Costs	Renewable resources more expensive due to integration and limited supply Northern Lights project from Canada increases supply	Utilities acquire minimum renewable resources Renewables integration add costs to NW transmission Reduction in BPA allocation	Renewable resources become more efficient and cost-effective Many homes and businesses acquire fuel-cell and solar technology SuperGrid creates more resource availability Nuclear power plants added in NW
Energy Prices	Natural gas, LNG & oil prices rise significantly Renewables drive prices upward	Electricity prices increase due to breaching of Snake River dams Oil, natural gas and LNG prices and supply both volatile	Electricity prices likely remain stable Oil, natural gas and LNG prices increase over time
Resource Siting, T&D	Transmission upgrades for entire region to accommodate renewables integration Remote generation less favorable due to transmission constraints Increased solar: possible response tool Plug-in Hybrids change load profiles and lead to transmission and subtransmission upgrades	Siting of resources focused on renewables requirements of I-937 Renewables integration challenges Transmission congestion continues to challenge getting resource to load Reduced power from BPA due to global warming and loss of Snake River dams	No transmission losses Many DG opportunities Siting not an issue Congestion on I-5 corridor transmission reduced More load density

Snohomish Co. PUD	Scenario #1 Growth & Consequences	Scenario #2 The Bleak House	Scenario #3 Tech Goes Nano
Environment	Emissions trading adds to costs Carbon Neutral generation carries high value	Significant global warming impacting environment and social/cultural practices Environmental changes to Federal hydro system when dams are breached	Continued focus on carbon neutral lifestyle
Conservation	Higher energy prices make conservation more cost-effective Conservation to mitigate resource risk DSM integrated into resource operations PUD can impact initial building process for many new developments	Fewer conservation measures cost effective Fewer residential/commercial efficiency opportunities Stranded conservation assets Possible fuel switching by residential sector	New nano-conservation opportunities Work at Federal level for efficiency standards on new technology Technology in home achieves higher efficiency yet number of appliances, entertainment and gadgets increase Work with manufacturers transform market PUD can impact initial building process for many new developments Smarter-automated commercial systems Smarter end-uses

APPENDIX D
PUD'S CLIMATE CHANGE POLICY

Snohomish County PUD
Adopts Climate Change Policy

POLICY

Snohomish County PUD will provide electric, water and associated services to its customers in an environmentally responsible way while increasing economic value, financial stability and operational safety and security for our ratepayers. Snohomish County PUD faces significant challenges and some uncertainty in serving community growth while at the same time addressing the issue of global climate change.

Climate change is a serious global problem, and we believe that it should be addressed through the development of thoughtful and forward-looking legislation that actually results in the reduction of greenhouse gas emissions in a workable and cost-effective manner. It is also important that any legislative solutions promote and provide incentives for the development and application of innovative technologies as part of a climate change strategy.

The Northwest's investments in energy efficiency and renewable hydroelectricity have yielded substantial environmental benefits. We will continue this legacy by meeting customer growth through conservation and a diverse mix of renewable technologies including, but not limited to, wind, tidal, solar, biomass, and geothermal.

Using our natural resources more efficiently and wisely makes good environmental and economic sense. Therefore, legislation to reduce greenhouse gas emissions, if done correctly, should not negatively impact the nation's economy or competitiveness.

Snohomish County PUD promotes the following principles to guide legislation and will incorporate the following strategies to guide our actions.

PRINCIPLES

- Legislative action to address climate change should involve all sectors of the economy and all sources of greenhouse gases.

- Any actions should consider the economic impacts on consumers, especially those who are financially challenged.

- Legislation and regulation should favorably recognize and credit the historical investments in energy efficiency and renewable resources, which have mitigated or avoided greenhouse gas emissions.

- We prefer a single, comprehensive, national approach to addressing climate change; however, if states or other local jurisdictions create related legislation, it should be compatible with other climate change initiatives in order to facilitate implementation and ensure reasonable certainty.

- A clear and definitive regulatory framework for climate change is an absolute necessity. Otherwise, it will be difficult for utilities to determine the most prudent path for securing and maintaining the necessary financing capability to make appropriate long-term investments.

- The Northwest region should not be required to subsidize the mitigation of greenhouse gases in other parts of the country that depend on substantial fossil fuel generation. The Northwest has been mitigating, at considerable cost, the environmental impacts (e.g., fish and wildlife) associated with its hydro-based generation. At the same time, the Northwest faces significant growth pressures that will demand large financial investments to acquire the necessary levels of new renewable technologies.

- Each region of the country should mitigate its own environmental impacts and implement its own new technologies such that the investment associated with the reduction of greenhouse gas emissions is consistent with the level of contribution to the problem.

- The two most commonly debated approaches to stimulating investment in new clean technologies are “carbon or production taxes” and “cap-and-trade.” At this time, we do not support one approach over the other. Both approaches have inherent complexities and attributes that can either help or penalize the Northwest. There are some over-arching basic principles that should drive the debate about these two approaches:

    - If a production or carbon tax approach is considered, it should only apply to those activities that actually produce greenhouse gas emissions. Such a tax on existing or future renewable resources is both illogical and counterproductive.

- If a cap-and-trade approach is considered, allowances should be allocated equitably (e.g., load based) across the utility industry and should not be based on current or historic levels of greenhouse gas emissions. To do otherwise would be to reward high-emissions regions while penalizing those whose contribution to the problem has been minimal.

STRATEGIES

- Reduce energy use by improving the energy efficiency of our own utility generation, transmission, distribution, and administrative facilities.

- Fully comply with state requirements (I-937) to secure all cost-effective conservation from our customer base.

- Utilize integrated resource planning standards that: a) consider the long-term costs and risks associated with greenhouse-gas-emitting generation sources and b) consider a diversity of resource options that provide the optimum balance of environmental and economic elements.

- Monitor emerging technologies and best practices for local application where appropriate.

- Monitor and evaluate the actual changes that are occurring in the climate (e.g. snow pack, etc.) and adapt effectively to the actual impacts of climate change on our utility operations.

- Educate our customers and promote public awareness on climate change issues.

- Influence public policy forums on climate change at the local, state and national level for the benefit of our ratepayers.

- Support the creation and location of innovative industries in our service territory that manufacture products or offer services that reduce greenhouse gas emissions.

- Support and recognize the efforts of our employees in the creation and deployment of innovative programs and actions to reduce both their individual and the PUD's contribution to greenhouse gas emissions.

- Seek to reduce greenhouse gas emissions resulting from non-generation activities by modifying activities where it can be accomplished at a reasonable cost while still maintaining high levels of customer service.

- Evaluate, on an ongoing basis, how the Policy, Principles and Strategies outlined in this document are helping us meet our overall goals and make adjustments when and where appropriate.

APPENDIX E
FUTURE ENERGY TECHNOLOGY

Organic Photovoltaic Cells


Photo credit: Warren Gretz, National Renewable Energy Laboratory

The current industry standard for solar energy is that of silicon based photovoltaic cells. These cells, however, are quickly reaching their peak cost-to-effectiveness ratio. Organic photovoltaic cells, however, are innovative in the sense that they are far more versatile. They function by absorbing incoming solar radiation, which excites the cell polymer. The energy transfer mechanism is the important part of this technology, preventing waste from occurring. Possibly the most innovative and integrative aspect of these organic cells is their ability to be painted onto surfaces. Given this new technology, solar power could become a viable source of energy in the near future.

Cellulosic Biofuel

The traditional form of biofuel is corn starch converted into ethanol, via an enzyme that releases sugars within the starch. The sugars in organic cellulose are difficult to extract due to the complex nature of cellulose itself. At the moment, the cost of extraction I up to 50 cents per gallon of fuel produced (in comparison to the 3 to 4 cents per gallon of corn ethanol). However, scientists are working on a more efficient method of releasing the sugars. The benefits of cellulosic fuels are related to emissions: whereas corn ethanol burns 25% cleaner than gasoline, cellulosic fuels burn nearly 85% cleaner. While they are not currently economically feasible, the rapid advances of science make Cellulosic biofuel a promising new green energy source.[1]

Hydrogen

Hydrogen is found in many organic compounds, as well as in water. It is the most abundant element on the earth. Hydrogen is always combined with other elements, but once separated it can be burned as a fuel and converted into electricity.

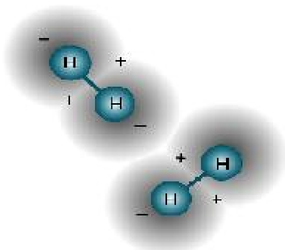
Hydrogen can be produced from numerous hydrocarbons including gasoline, natural gas, methanol, propane, and coal. It can also be produced from water using electrolysis. Hydrogen has the highest energy content of any fuel and produces almost no pollution. In the future,

[1] Goho, Alexandra. "Cellulolytic Enzymes." Technology Review. Published April 2008. http://www.technologyreview.com/read_article.aspx?ch=specialsections&sc=emerging08&id=20240

hydrogen could join electricity as an important energy carrier. The energy for producing hydrogen can be provided by renewable resources including wind and solar. It can then be stored and transported to provide energy to consumers via fuel cells or other technologies.

At least one group is exploring the potential for creating hydrogen through electrolysis, using off-peak hydropower capacity. The hydrogen would be stored as hydrogen-rich compound ammonia, transported to strategically placed distributed generation facilities, and burned in an ammonia-fueled internal combustion engine (which is reportedly under development).

Titania Hydrogen



In the past, using hydrogen as a fuel source has been expensive and not particularly clean. The most popular method of obtaining hydrogen is to split it off from natural gas, which produces a large amount of carbon dioxide. A company called Nanoptik has announced a method which is as efficient as any alternative, with the added bonus of producing no carbon dioxide. Titania, an abundant material, has been used in the past to split hydrogen from sunlight; however, the only sunlight which could be used for this process lied in the ultra-violet spectrum. Nanoptik however, has refined a process using nanotechnology to boost the light available for use in the visible spectrum, which allows for greater amounts of hydrogen to be produced. With further innovation in this field, there is great potential for electricity generation in the future.[2]

Ethanol Efficiency

Researchers with the Coskata Company are making rapid advances with a process using bacteria to create ethanol. In a normal ethanol creation process, corn grain is used as the biological component, but with Coskata's new method, any organic substance can be used. By creating a more efficient method of creating ethanol directly from synthesis gas (a mix of Carbon Monoxide, Dioxide and Hydrogen) ethanol becomes far more cost effective. Coskata achieves this by using micro fibers within a bioreactor to house syngas eating bacteria. The syngas is pumped down the hollow micro fibers, which consume the syngas and produce ethanol. The ethanol is then carried away by water and filtered via a process called vapor permeation, which is far more efficient than the current method of distillation. These multi-tiered improvements to the process show that as technology advances, alternative fuels will become far more abundant and cost effective.[3]

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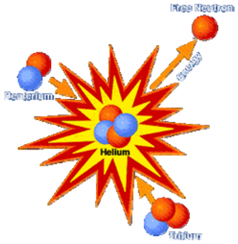
[2] Bullis, Kevin. "Cheap Hydrogen." Technology Review. Published January 31, 2008.
http://www.technologyreview.com/Energy/20134/

[3] Bullis, Kevin. "Ethanol from Garbage and Old Tires." Technology Review. Published March/April, 2008.
http://www.technologyreview.com/Energy/20199/page1/

Fusion Technology



While nuclear fission is currently producing net electricity, nuclear fusion has yet to be a stable, net energy producing technology. In the reverse of nuclear fission, fusion technology collides two Hydrogen isotopes together to form what is usually Helium, and in the process create energy. The primary roadblock to harnessing this technology is creating a stable, sustained fusion reaction which produces energy. Fusion reactions have, in the past, been created for very short periods of time, but as of yet have not been sustained. The benefits of fusion technology are vast: it produces large amounts of energy, its fuel source (if including lithium to create a hydrogen isotope) is expected to last for millions of years and it produces no greenhouse gases or byproducts. Scientists estimate that fusion technology is still far into the future, with active reactors no earlier than 2050, but the benefits of such a reactor are too large to ignore.[4]

Wireless Electricity

While not an explicit generation method, one of the most difficult problems faced by any electrical utility is the transmission of electricity. Recently, researchers at MIT have been working with transmitting electricity without the use of a directly connected wire. By setting up coils with matching magnetic frequencies, power can be “transmitted” via the magnetic waves. Other companies have picked up on this and are testing the technology with small appliances. One company has gone so far as to build a laptop which wirelessly charges via a coil built into a special desk. While this technology is currently extremely experimental, the wide range of applications could prove to be invaluable.[5]

Flameless Combustion

Middle Eastern researchers in Abu Dhabi and Tunisia have discovered a method of combustion which seems, at first, not to be combustion at all. The process, known as flameless combustion (or in technical terminology, flameless oxidation) occurs when fuel oxidizes with very low oxygen levels and at a very high temperature. Spontaneous combustion occurs with no visible or audible sign of the flame typically associated with a combustion engine. The primary advantage of this process is significantly less Nitrous Oxide emissions, which is a chief contributor to toxic pollutants. If this method is found to have comparable energy output and capital costs to current combustion techniques, the marked decrease in emissions makes it a strong candidate for future adaptation.[6]

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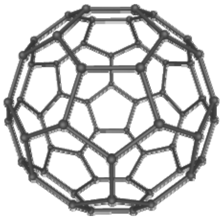
[4] Various. “Fusion Power.” Wikipedia Modified March 7, 2008. http://en.wikipedia.org/wiki/Fusion_power

[5] Chu, Jennifer. “Wireless Power.” Technology Review. Published March/April 2008. http://www.technologyreview.com/read_article.aspx?id=20248&ch=specialsections&sc=emerging08&pg=1

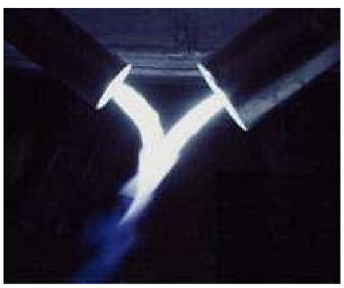
[6] Dalton, Steward. “The Future of Coal Under Carbon Cap and Trade.” Testimony, Hearing on the Select Committee on Energy Independence and Global Warming. Published Sept. 6, 2007. http://mydocs.epri.com/docs/CorporateDocuments/Newsroom/Testimony/Testimony-Dalton-090607.pdf

Nanotechnology



Last but far from least is the rapidly advancing field of nanotechnology. Nanotechnology is in actuality a catch-all phrase which refers to many differing fields and deals with the science of manipulating matter at a very small level. “Nano” refers to the scale on which these changes take place (a nanometer is one billionth of a meter). Most technologies referred to as nano are smaller than 100 nanometers wide, which is the typical size of an individual virus cell. Some applications of these devices include prolonging battery life. By increasing the density while allowing the chemicals to be separated when not in use at the nano level, energy storage devices can become extremely viable and potent in the market. Another application is the increased efficiency from generation nanotechnology can provide. While the method will vary between generation techniques, the possibility of highly efficient combustion, solar and other technologies may mark a revolution in electricity generation. These are just some of the potential applications of nanotechnology; it would be prudent to keep a close eye on the development of this field.[7]

Plasma Gasification



The process of converting waste into superheated gas (or in some cases, atomizing it) is known as Plasma Gasification. By running a high voltage current between two adequately spaced electrodes, one creates an arc. By passing an inert gas under pressure through the arc and into a sealed container which holds waste, the temperatures exceed 25,000 degrees Fahrenheit. These temperatures convert the waste into its elemental constituents in a gaseous form. While this process does require a large amount of electricity to operate, the elemental components which are produced can be used as Syngas, which is an efficient renewable source of electricity. Plastics, which are primarily carbons and hydrogens are most effective at producing Syngas. This process has been under study for some time now, with a number of various entities beginning to pursue this. With a reasonable time horizon for research, this process could be made extremely efficient, providing both waste disposal and net generation on into the future.[8]

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[7] Somenath Mitra and Cheng Li. “Unique nanotube composites constructed for organic solar cells.” SPIE Published 2007. http://spie.org/x19641.xml?highlight=x2358

[8] “Plasma arc waste disposal.” Wikipedia. Modified April 11, 2008. http://en.wikipedia.org/w/index.php?title=Plasma_arc_waste_disposal&oldid=204864589

APPENDIX F
PUBLIC UTILITY DISCOUNT RATES

EXECUTIVE SUMMARY

This paper examines the appropriate investment discount rate for Snohomish County PUD. Discounting converts costs and benefits in different years to one scale, called net present value (NPV). The discount rate reflects the relative importance we give to costs and benefits over time. For investment purposes, the level of the discount rate is closely related to the level of interest rates. The challenge lies in determining which interest rate is the appropriate reference for Snohomish PUD.

There are three general approaches that can be used for this choice: the corporate, regional consumer, and societal perspectives. The corporate perspective takes the view that discount rates should equal the firm's tax-adjusted weighted average cost of capital (WACC). The regional consumer's perspective is based on the different after-tax investment returns available to regional consumers. The long-term societal perspective argues for the using very low discount rates for societal investment decisions involving long-lived assets or consequences. Variable rate discounting is an example of approaches proposed to handle long-term consequences. A list of the posted discount rates for numerous regional electric power entities displays a wide range of numbers, with the highest being those used by the Bonneville Power Administration.

Returns from any Snohomish PUD investment must be at least sufficient to repay borrowed funds. The two most prominent references for setting the Snohomish PUD discount rate are 1) the PUD's cost of borrowing and 2) the PUD's WACC, basing the PUD's expected return on equity on that of the ratepayers. Snohomish PUD's customers spend just one percent of their incomes on electricity, and the utility's cost of borrowing falls within the range of returns customers receive on their investments. We find that Snohomish PUD should base its discount rate on its cost of borrowing. The choice is consistent with what the Northwest Power and Conservation Council assumes for municipal utilities. The recommended discount rate of 5 percent is based on current long-term AA municipal bond rates.

INTRODUCTION

Investment analysis requires the comparison of projects with different time patterns of costs and benefits. A conservation project or a renewable energy installation, for example, is often characterized by high up-front capital costs and low operating expenses, whereas a coal or gas plant typically has lower up-front capital costs and higher operating expenses. Discounting converts costs and benefits in different years to one scale, usually called present value (PV). When looking at annual cost and benefit streams of various resource types, discounting is required to compare and choose among alternative policies. The discount rate reflects the relative importance we give to costs and benefits in the present and the future—a higher discount rate reduces the importance of future effects, whereas a lower discount rate lends greater weight to future effects.

For investment purposes, time preference is tied to the concept of a market interest rate. Paying a certain amount next year is less of a burden than paying the same amount this year. That is because one could invest less than that amount today and, given sufficient return on that investment, use the proceeds to pay the full amount next year. Individuals and businesses with a high value for current consumption will tend to borrow, and others will lend them money in exchange for a sufficient return. The net effect of this supply and demand for money is a major factor in setting the level of interest rates. Market interest rates also embody considerations of uncertainty of repayment, inflation uncertainty, tax status, and liquidity, which together account for most of the variations among observed interest rates. This point is nicely summarized in Northwest Power and Conservation Council (NWPCC) discount rate analysis.

Rates that reflect returns after accounting for the effects of inflation are called real interest rates, whereas rates that do not take inflation into account are called nominal interest rates. Positive inflation is the norm, so nominal interest rates are generally higher than real interest rates. In recent years, annual inflation in the U.S. has been between 1.5 and 3.5 percent.

PUBLIC ENTITIES AND DISCOUNT RATES

The level of the discount rate is closely related to the level of market interest rates, which are a product of time preferences expressed throughout society. The question is which interest rate is the appropriate reference for a public institution like Snohomish PUD. There are three general approaches available for this choice: the corporate perspective, the regional consumer perspective, and the societal perspective.

Corporate Perspective

The literature on corporate investment decisions almost uniformly holds that the correct discount rate is the firm’s tax-adjusted cost of capital. While most of the literature focuses on private corporate entities, this perspective is also applicable to entities with other forms of ownership if they are externally financed. Using the corporate cost of capital as the discount rate is meant to ensure that investments maximize value to the owners of the firm.

A second argument in favor of this perspective applies even to entities without stockholders or that focus on something other than owner wealth maximization. This argument holds that the majority of the investment decisions in the U.S. are made by private corporations that use this investment rule. To use a different rule for a limited sector would distort investment patterns in the overall economy, leading either to over-investing or to under-investing, depending on whether the discount rate is lower or higher than standard.

Following this perspective, a public institution would use its weighted average cost of capital (WACC) as the basis for its discount rate. For a public utility, the WACC is composed of borrowed funds and reserves derived from customer rates.

Regional Consumer’s Perspective

The regional consumer’s perspective is based on after-tax investment returns available to regional consumers. There are numerous different interest rates that individuals pay and receive, ranging from savings accounts earning at rates below inflation to the high cost of credit card interest. Regarding capital investments, stock and bond investments likely best represent the household consumer's rate of time preference; most after-tax stock and bond returns currently range between 4 and 8 percent. A representative rate for the regional consumer's equity likely lies in that range.

Societal Perspective

A long-term societal perspective argues for the use of very low discount rates in societal investment decisions. 'Societal investment' is difficult to define; it logically encompasses public sector investment, but some would extend it to the endeavors of any group of people who band together to pursue a purpose. Where individual interests are served by maximizing returns, the long-term interests of society as a whole may suffer from decisions made with a focus on short-term outcomes. Proponents of the long-term perspective argue that the cost of money and overall risk is lower for society as a whole than for individuals. In general, the rationale behind a lower societal discount rate emphasizes the importance of leaving a better world for future generations. Electric ratepayers in the Pacific Northwest, for example, enjoy low-cost power because hydroelectric dam investments were justified using low discount rates.

Using anything but the lowest discount rates means consequences that occur more than 100 years in the future have almost no importance. Table 1 below shows the present value of 100 dollars after discounting by varying years and rates. For each cell, a person using the corresponding discount rate would be indifferent between receiving that amount of money now and 100 dollars after the specified number of years.

Table 1. Present value in dollars of $100 at different discount rates and years in the future

	Discount Rate				
Years	**1%**	**2%**	**4%**	**6%**	**8%**
20	81.954	67.297	45.639	31.180	21.455
30	74.192	55.207	30.832	17.411	9.938
50	60.804	37.153	14.071	5.429	2.132
100	36.971	13.803	1.980	0.295	0.045
200	13.669	1.905	0.039	0.001	0.000

As can be seen in Table 1 above, using a 6 percent discount rate means that the current value of costs and benefits occurring after 100 years are just 0.3 percent of their future value, and events occurring after 200 years have a present value that is just 1/100,000th of their future value. The effects of even enormous events occurring in the distant future are simply discounted away to inconsequence at all but the lowest rates.

There are three main arguments opposing the very low interest rates suggested by the long-term societal approach. First, one can argue that higher short-term returns can be continuously reinvested so as to maximize returns (and by extension, well-being) at the end of long periods. Second, because each modern generation has been materially better off than the one that preceded it, one can argue that low discount rates encourage a transfer of wealth from current generations to future, wealthier generations. Third, one can argue that long-term societal consequences occur beyond the investment horizon. Such long-term issues are therefore appropriate for consideration in setting the public policy framework, but they should be kept separate from investment decisions made within the framework once it is set.

The challenge that very long time frames present for conventional discounting methods is clearly illustrated in the publishing and ensuing discussion of the British government's Stern Review of the Economics of Climate Change. The Stern Review predicted much direr economic consequences of climate change over the next century than had previously been seen in mainstream economic literature. Stern concludes that society must act now to reduce the potential for disastrous impacts occurring 50 to 200 years in the future. In subsequent criticism, prominent Yale economist William Nordhaus and others have noted that the primary difference between the Stern report and previous predictions is Stern's use of a 1.4 percent discount rate where others used rates in the more standard region of 6 percent.[9] The future consequences predicted in the Stern report are no worse than others have foreseen, but using a lower discount rate places much greater weight on the potential costs of those events in the distant future.

Nordhaus posits that Stern decided that the threat of climate change requires immediate action and then selected a discount rate to support that argument with economics. As Harvard economist Martin Weitzman noted, while Nordhaus raises valid objections to Stern's analysis, he does not offer a functional alternative for handling potential catastrophes in the 22nd century. [10] The entire debate illustrates the limits of conventional discounting when it comes to analyzing potentially enormous events set far in the future.

Additional Considerations

Variable-Rate Discounting

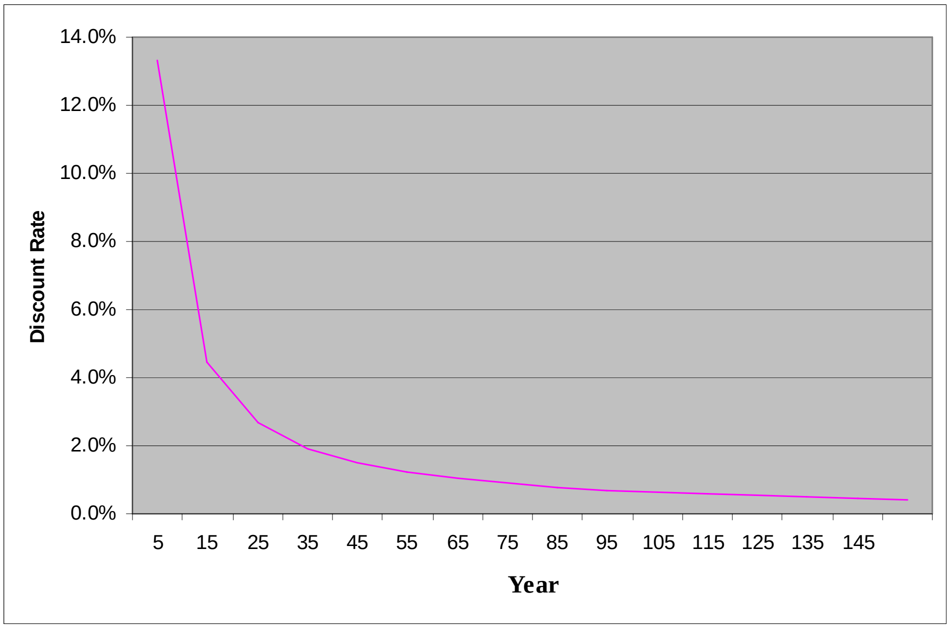
Based on concerns about excessively discounting the distant future, and partially based on empirical findings of how people mentally discount, some economic theorists have proposed a variable-rate discounting approach. Hyperbolic discounting is one commonly discussed version of variable-rate discounting. In hyperbolic discounting, the discount rate is inversely proportional to the time period over which the value is to be discounted:

$$r = \frac{1}{kD}$$

where r is the discount rate, k is a constant reflecting the degree of discounting, and D is the time period. An example of how a hyperbolic discount rate changes with time is shown in Figure 1. As one can see, one challenge of hyperbolic discounting is that the discount rate approaches infinity as the reference time approaches zero. Any practical use of hyperbolic discounting would need to include external limits on the initial rates.

Figure 1. Hyperbolic Discount Rate Example

[9] See *Science Magazine*, Volume 317 (July 13, 2007), pp. 201-202.
[10] *Journal of Economic Literature* Vol. XLV (September 2007), pp. 703–724.



A number of experiments have confirmed for both human and nonhuman subjects that a graph of spontaneous time preferences resembles a hyperbolic curve more than the conventional curve in common use. For instance, when offered the choice between $50 now and $70 a year from now, many people will choose the immediate $50. Given the choice between $50 after 20 years and $70 after 21 years, people are apt to wait longer for the higher reward. The wait no longer seems so long relative to the gain, even though the second scenario is simply the first scenario projected 20 years in the future.

The fact that an investment opportunity varies in attractiveness depending on when it is considered is referred to as time inconsistency. Time inconsistency is problematic in investment analysis. For example, using hyperbolic discounting, we might find that the high immediate costs of a project outweigh the benefits it generates in the future. When we discount with time inconsistency, it might seem optimal to implement the same project in five years, since the future costs would then be discounted along with the benefits. Of course, five years later when the time arrived to implement the project, the same analysis would again indicate it would be optimal to delay implementation. In order to carry out the project, we would need to commit our future selves and then stick to the plan despite the fact that it would not seem worth it from the closer perspective.

Accounting for Risk

One common way of accounting for additional investment risk is to adjust the relevant discount rate by adding a risk premium. BPA uses a higher discount rate for power than for transmission projects because there is higher revenue volatility in power projects. In contrast, NWPCC has explicitly separated risk calculations and discount rates. They reason that the discount rate should simply reflect the cost of money and the time preference for consumption, and that risk analysis should be conducted separately in making investment decisions. In the interest of simplicity and transparency, it is recommended for Snohomish PUD to separate risk calculation from the discount rate.

SETTING THE DISCOUNT RATE FOR SNOHOMISH PUD

At a minimum, a successful project must return benefits at a rate equal to the PUD's cost of borrowing. Investment analysis using a discount rate set below the PUD's cost of borrowing could indicate positive returns for capital projects that would not be able to pay back borrowed funds. The shortfall in returns from such a project would require subsequent retail rate increases. Regarding the prospect of using very low discount rates suggested by the long-term societal approach, it is important to note that concern for well-being of future generations is already reflected in Washington State and Snohomish PUD policies. Specifically, focusing on renewable, low carbon energy options for new power generation reflects concern for potential consequences of climate change in the distant future.

Discount Rates Used by Relevant Regional Institutions

When considering the appropriate discount rate for Snohomish County PUD investment projects, it is natural to consider what rates comparable organizations in the region have chosen.

Table 2. Recent published utility discount rates for investment analysis

Organization	Discount Rate (%)	Real/ Nominal	Source	Stated Rationale
Avista	7.41	Nominal	2007 IRP	Not listed
BC Hydro	6.0	Real	2007 IRP	Not listed
Pacificorp	5.1	Real	2007 IRP	Cost of capital
PSE	7.7	Nominal	2007 IRP	Current cost of long-term debt
SCL	8.9	Nominal	2007 IRP	Assumed cost of capital for privately owned IPP
SMUD	6.25	Nominal	2007 DEIS	Not listed
PG&E	8.0	Nominal	2007 DEIS	Not listed
BPA	9 / 13	Nominal	Planning Report	Sought to behave like a traditional utility
WAPA	9.4	Nominal	2002 Cal ISO Board Memo	Not listed
NWPCC	4.0	Real	5th Power Plan	Weighted estimate of discount rates of regional utilities

For planning, Seattle City Light (SCL) assumes that generation projects would be developed by private, third-party developers. SCL's listed discount rate of 8.9 percent is actually NWPCC's estimation of the after-tax WACC for an IPP based on 60 percent debt financing at 7 percent with a 15 percent return on capital.

Sacramento Municipal Utility PUD (SMUD) does not explain its discount rate of 6.25 percent. SMUD's 2007 DEIS notes that its long-term bond interest rate is 4.4%, its expected return on equity is 6.6%, and its debt to equity ratio is 80:20. Using those figures to calculate WACC would suggest a figure of 4.8 percent.

Similarly, PG&E does not explain its 8.0 percent discount rate. PG&E notes that its long-term bond interest rate is 7.2%, its expected pre-tax return on equity is 11.9%, and its debt to equity ratio is 55:45. That indicates a pre-tax WACC of 9.3 percent.

BPA has a limited capacity to borrow, set by Congress, so they must limit the projects they undertake. One approach to operating with limited capital would be to rank projects according to their investment criteria and to choose the top projects within their finance limits. Alternatively, they can impose a high discount rate, so that only those projects that return profits most quickly are eligible. The latter appears to be BPA's approach. In both cases, only the most beneficial projects would be chosen, but using different discount rates would likely change which projects were deemed most beneficial.

The NWPCC discount rate is intended to reflect a weighted average of the discount rates used by utilities and power producers in the region. Table 3 below displays NWPCC discount rate estimates for utility-related entities in the region.

Table 3. NWPCC discount rate estimates

	Real (%)	**Nominal (%)**
Municipal Utility	2.3	4.9
IOU	5.0	7.7
IPP	6.1	8.9

Source: NWPCC 5th Power Plan, May 2005

NWPCC derived the estimates in Table 3 from 10-year Treasury notes. They assumed 100% debt financing for municipal utilities and 60% debt financing for IOUs and IPPs. In short, NWPCC assumes that consumer-owned utilities will base their discount rates on their cost of borrowing.

Snohomish PUD's Cost of Borrowing and WACC

Recognizing that returns from Snohomish PUD investments must match our cost of borrowing, the two most prominent possible references for setting SnoPUD's discount rate are:

1. Snohomish PUD's cost of borrowing
2. Snohomish PUD's WACC, where the rate applied to the equity share reflects the ratepayers' expected return on equity

In general, the PUD's capital projects are financed through a combination of borrowing, direct charges to ratepayers, and rates designed to accumulate capital funds. Debt financing is limited to a maximum of 40 percent of the cost of non-generation capital improvements, but generation projects can be 100-percent debt financed.

Snohomish PUD's equity for capital investment is effectively the ratepayers' equity, meaning that the PUD's expected return on equity should reflect the ratepayers' expected return. Financial goals and situations will vary among individual ratepayers, and for each individual, a portfolio encompasses numerous investments with varying degrees of risk and expected return. Electricity bills generally represent a relatively small share of Snohomish PUD's ratepayers' incomes, approximately 1 percent. The PUD's cost of borrowing falls within the range of rates consumers commonly receive on investments, and it is a legitimate option as a representative rate for a small, low-risk part of a consumer's broader financial portfolio. It is therefore reasonable to assume that the expected rate of return for ratepayers on electric infrastructure assets is comparable to the PUD's cost of borrowing. Consequently, the two references both indicate that Snohomish PUD's discount rate could be based on its cost of borrowing. At this writing, the bond rate for 20-year and 30-year AA bonds is 4.45 percent. For simplicity, and to accommodate the volatility of a market rate, a 5 percent discount rate is recommended for the PUD.

Conforming with NWPCC

Under the renewables portfolio standard established by I-937, the PUD is required to pursue all cost-effective conservation measures as judged by "methodologies consistent with those used by the [NWPCC] in its most recently published regional power plan."[11] As was previously noted, the NWPCC assumes that municipal utilities will use their cost of borrowing as a discount rate.

CONCLUSION

The two most prominent possible references for setting Snohomish PUD's discount rate are 1) the PUD's cost of borrowing and 2) the PUD's WACC, where the rate applied to the equity share reflects the ratepayers' expected return on equity. Choosing a reasonable representative rate of return for ratepayer equity suggests that the two references are the same. Snohomish PUD's discount rate for investment decisions should therefore be equal to its cost of borrowing. That approach is further supported by NWPCC's expectations for municipal utilities. Snohomish PUD can borrow for capital investment by issuing high-grade municipal bonds. At this writing, the bond rate for 20-year and 30-year AA bonds is 4.45 percent. For simplicity, and to accommodate the volatility of a market rate, a 5 percent discount rate is recommended for the PUD. The discount rate should be reexamined on a regular time interval or after significant changes in market rates.

[11] I-937, section 4a.

APPENDIX G

ENERGY-RELATED TERMS & DEFINITIONS

average megawatts (aMW)

The unit of energy output over a year, equivalent to the energy produced by the continuous operation of one megawatt of capacity over a period of time; also an average of one million watts transferred over a period of time (often a year, thus average annual megawatts).

Bonneville Power Administration (BPA)

The Federal power marketing agency under the Department of Energy responsible for marketing wholesale electric power from 30 Federal dams and one non-Federal nuclear plant throughout Washington, Oregon, Idaho, and western Montana and portions of California, Nevada, Utah, and Wyoming. BPA also sells and exchanges power with utilities in Canada and California. Also known as "Bonneville."

kilovolt (kV)

One kilovolt equals 1,000 volts.

Investor Owned Utility (IOU):

A privately owned utility organized under State law as a corporation to provide electric power service and earn a profit for its stockholders. A private utility.

megawatts (MW)

The electrical unit of power which is equal to 1,000 kilowatts, or 1,000,000 watts.

megawatthours (MWh)

Electrical energy equal to one megawatt of power supplied to or taken from an electric circuit for one hour (1 MWh = 1,000 kWh = 1,000,000 watthours).

Public Utility District (PUD)

A political subdivision, with territorial boundaries for an area wider than a single municipality and frequently covering more than one county, established by voters to supply electric or other utility service. Called Public Utility Districts in Washington and Peoples' Utility Districts in Oregon. Hold preference customer status in buying power from BPA.

Renewable Energy Credit (REC)

As defined by Washington State's Energy Independence Act (I-937) Final Rules: "Renewable energy credit" or "REC" means a tradable certificate of proof of at least one megawatt-hour of an eligible renewable resource where the generation facility is not powered by fresh water, the certificate includes all of the nonpower attributes associated with that megawatt-hour of electricity, and the certificate is verified by the renewable energy tracking system chosen by the department [CTED]."

volt (V)

The unit of electromotive force, or voltage, that if steadily applied to a circuit having a resistance of one ohm will produce a current of one ampere.

watt (W)

1) The electrical unit of power. 2) The rate of energy transfer when one ampere is passing across one volt. Analogous to horsepower or footpounds per minute of mechanical power (one horsepower is equivalent to approximately 746 watts; one kilowatt equals 1,000 watts; one megawatt equals 1,000,000 watts). A 100-watt light bulb requires 100 watts of electricity to operate.